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1912

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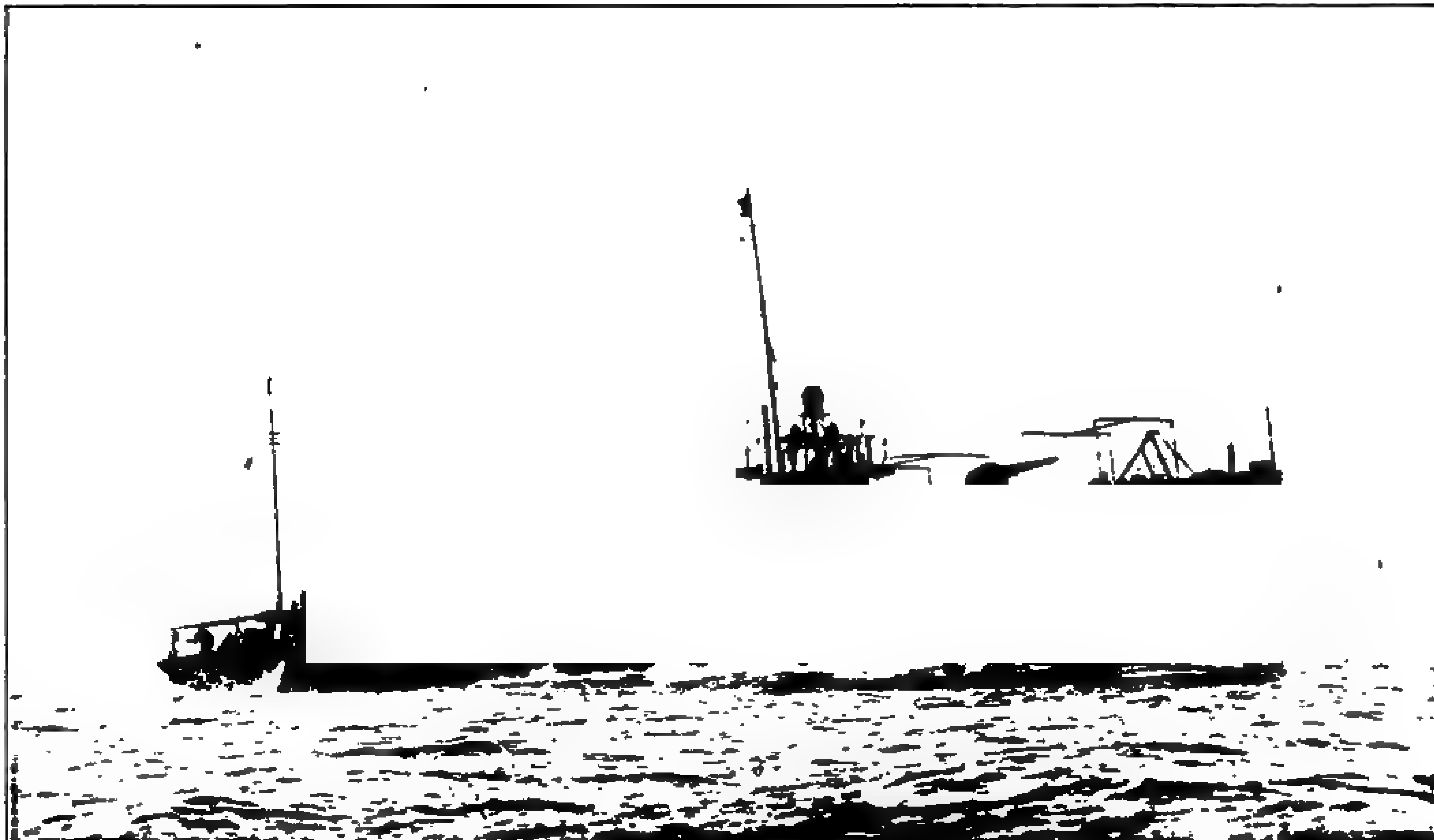


Photo by Boston Photo News Company.

U. S. DESTROYER FLUSSER.

(1907–1909)

Displacement, 700 tons; designed speed, 28 knots, on trials made 33.7 knots; Parsons turbines; 18-inch Bliss-Leavitt torpedoes.

P. Stanley

JOURNAL

OF THE

UNITED STATES ARTILLERY

"La guerre est un mêtier pour les ignorans et une Science pour les habiles gens."

VOL. 37 No. 1 JANUARY—FEBRUARY, 1912 WHOLE No. 113

THE ELECTRICAL COURSE, DEPARTMENT OF ENLISTED SPECIALISTS, COAST ARTILLERY SCHOOL

BY LIEUTENANT ADELNO GIBSON, COAST ARTILLERY CORPS

Instructor, Department of Enlisted Specialists, Coast Artillery School

The master electricians and electrician sergeants who have charge of the fire control and other electrical equipment of the coast artillery form a body of men of very great importance to our arm of the service. It is of unquestioned importance that every officer should understand what type of man composes this group of specialists, the process of training given him in the school at Fort Monroe, and what may reasonably be expected of him as a result of this training. This knowledge will be of especial value to the artillery engineer but will not lack in value to every officer of the coast artillery. All officers will thereby be better informed as to the character and capabilities of a portion of the troops they may command, and will be in a position to aid ambitious men of the service, and incidentally to benefit the school and corps, by knowing what men are suited for the requirements of the school course, and by advising and aiding such men in their efforts to enter the school.

The fundamental purpose of the electrical course is to furnish to the corps electrician sergeants, who can install, operate, and keep in repair the electrical equipment of our coast forts. Conditions have been such that few officers other than those directly connected with the school have had an opportunity

to know what type of man the school attracts and what sort of training the school gives.

The school was established at Fort Monroe, Virginia, May 22nd, 1900, per G. O. No. 71, A. G. O., May 22nd, 1900; was discontinued at Fort Monroe and transferred to Fort Totten, N. Y., December 2nd, 1901, per par. 3, G. O. No. 157, A. G. O., dated December 2nd, 1901; was discontinued at Fort Totten and moved to Fort Monroe on August 1st, 1908, per G. O. No. 27, W. D., March 3rd, 1908, where it became a part of the Enlisted Specialists Department of the Coast Artillery School.

The students are selected by written, competitive examinations held each spring throughout the coast artillery. Any soldier who will have served at least eighteen months in the coast artillery immediately prior to the beginning of the school term, is eligible to enter the competitive examination. The thirty men heading the competitive list are selected as students.

The limited facilities which made the course of instruction a compromise affair in the past have been increased year by year until this year finds the school for the first time with sufficient apparatus and other resources to train men in a way to give the service all-round electricians and to give the men an excellent electrical and mechanical training.

In formulating the course of study, the purpose has been, 1st, to furnish the coast artillery with competent electrician sergeants; 2nd, to give the men as comprehensive and thorough an electrical and mechanical engineering training as can be compressed into ten months. To limit the training to that necessary for a proper performance of an electrician sergeant's duties would not be living up to the opportunities of the school. The furnishing of competent electrician sergeants to the corps is but a part of the service rendered by the school. The fact that the high morale of Napoleon's soldiers was due in a large measure to the belief that each man carried a Field Marshall's baton in his knapsack, has some bearing upon our school proposition. Every opportunity that is afforded our soldiers to better their state attracts a higher grade of men to the service, raises the morale of the whole body, and brings the army more in accord with our democratic institutions. The road to a commission is as well marked and as easy to travel as fairness and public policy could desire. But a large number of most ambitious and excellent soldiers cannot comply with the requirements for becoming commissioned officers. To many of these, the course at the school, and the position of electrician sergeant with the eventual

opportunity of becoming a master electrician affords the substitute to the Field Marshall's baton.

Although but thirty men can enter the school each year, the opportunity to compete is open to all and the numerous schools of preparation voluntarily organized at various posts attest to the interest that men take and to the benefit that a large number of men receive, who never enter the school. The various correspondence schools gain many earnest students due to the ambition aroused by the possibilities afforded by the school. The course as laid down would not be possible wera it not for the fact that most men entering the school spend a year or more in preparation before taking the entrance examination. This fact is worthy of note as being of considerable value to the corps. The course of study is intended for men who have an elementary knowledge of electricity and of power plant operation, a thorough knowledge of arithmetic, and a large capacity for work. The admirable type of men who come to the school, the earnestness with which they work and their looking upon the course as the opportunity of a lifetime, are facts of great value to the corps.

The courses of study and the text books used are given below.

Courses of Instruction, and Text and Reference Books Used in the Electrical Course, Department of Enlisted Specialists, Coast Artillery School

I

DIRECT CURRENTS

Including Elementary Electricity, Measuring Instruments, Dynamos and Motors, Electrical Testing, etc.

Time—3 months.

1. Lessons in Practical Electricity, Swoope.
2. Vol. 11B, I.L.T., International Text Book Co.
3. Vol. 12B, I.L.T., International Text Book Co.
4. Electrical Catechism, Shepardson.
5. Testing of Dynamos and Motors, Smith.
6. Questions and Answers About Electrical Apparatus, Clayton & Craig.
7. Elementary Electrical Engineering, Direct Currents, Franklin & Esty.
8. Circular No. 20, Bureau of Standards.
9. Industrial Measuring Instruments. Edgecombe.
10. Electricity Meters, Solomon.

II

ALTERNATING CURRENTS

Time—1 month.

1. Vol. 12B, I.L.T., International Text Book Co.
2. Electrical Catechism, Shepardson.
3. Questions and Answers About Electrical Apparatus, Clayton & Craig.
4. Practical Alternating Currents, Smith.

III

FIRE CONTROL

Including Telephones, Time Interval Clocks, Time Interval Bells, etc.

Time—1 month.

1. U. S. Signal Corps Manual, No. 3.
2. U. S. Signal Corps Manual, No. 8.
3. Vol. 25B, I.L.T., International Text Book Co.
4. American Telephone Practice, Kempster B. Miller.

IV

TELEPHONE CABLE SPLICING, AND JOINTS AND SOLDERING, IN ELECTRIC WIRING

Time—2 weeks.

1. Pamphlet on "Joints and Soldering in Electric Wiring," issued by the Department of Enlisted Specialists.
2. Practical Hints on Joint Wiping, published by David Williams Co.
3. U. S. Signal Corps Manuals, Nos. 3 and 8.
4. International Correspondence Schools Instruction Paper, No. 822.
5. Electric Wires and Cables, Catalog and Handbook of American Steel & Wire Co.
6. American Telephone Practice, Kempster B. Miller.

V

SEARCHLIGHTS

Time—1 month.

1. Artillery Note, No. 31. (Now in process of revision as Artillery Note No. 32.)
2. Searchlights, Nerz.
3. Fourth and Eighth Supplements to Engineer Mimeograph No. 39, on the Care and Operation of the 36-inch Portable Searchlight Outfit.

VI

STORAGE BATTERIES

Time—2 weeks.

1. Vol. 14B, I.L.T., International Text Book Co.
2. General Instructions for the Operation and Care of the Chloride Accumulator, by the Electric Storage Battery Co.
3. Catalogs and Pamphlets on the Edison Storage Battery.

VII

GAS ENGINES

Time—1 month.

1. The Gas Engine, Cecil P. Poole.
2. Instruction Book No. 8402, on the 25-Kw. Direct-Connected Gas Motor Set, General Electric Company.
3. Fourth and Eighth Supplements to Engineer Mimeograph No. 39, on the Gas Engine used with the 36-inch Portable Searchlight Outfit.
4. Vol. 93, I.L.T., International Text Book Co.
5. Vol. 94, I.L.T., International Text Book Co.

VIII

MACHINE SHOP PRACTICE

Time—1 month.

1. Vol. 1B, I.L.T., International Text Book Co.
2. Vol. 2B, I.L.T., International Text Book Co.
3. Practical Machinist, Rose.

IX

BOILERS AND ENGINES

Time—1 month.

1. Engines and Engine Running, Rose.
2. The Fireman's Guide, Dahlstrom.
3. Steam Power Plant Engineering, Gebhardt.
4. Power and Power Transmission, Kerr.
5. Steam Trade Pamphlet, Babcock & Wilcox, N. Y.
6. Vol. 6B, I.L.T., International Text Book Co.
7. Vol. 7C, I.L.T., International Text Book Co.

The list of books may seem rather formidable, but nevertheless all are very thoroughly thumbed by the end of the year. There are no honorary volumes.

The liberal amount of apparatus, the number of instructors and the limited number of students make the applicatory system of instruction possible to an extent that is probably not the case in any other school. The system as carried out involves a large amount of work by the instructors and would not be possible in any large school. The method pursued is to issue to each student a systematically arranged set of problems in each of the nine subjects comprising the course. These problems call for theoretical study and then the practical application of the theory. There is nothing original in this method, but all the ingenuity of the instructors has been concentrated upon arranging devices for testing a man's practical knowledge of the theory. The result is that in nearly every instance a student

has some device, to show him without question whether he understands the theory. As an example, Fig. 1 shows a device arranged to determine a student's proficiency in testing for grounds, or crosses, in telephone cables. The box contains two coils of No. 25 copper wire, 1,000 feet in each coil. The ends of each coil are brought out to binding posts as shown. One set of binding posts form the zero, or station, end and the other set the far end, or 1,000 foot point. Each coil has several taps brought out to binding posts in the box. The distances from the zero

Fig. 1.

end to the points at which the taps are taken off are marked on the respective binding posts to which the taps lead. A binding post on the outside of the box is marked "ground" and a free wire leads from it to the interior of the box. By connecting the ground wire to any binding post in the box, the cable is grounded at the distance from the zero end marked on that particular binding post. The box is locked and turned over to a student for test by the Murray, or the Varley, loop, or the slide wire bridge method. When the student has computed the distance to the fault, the box is unlocked and he sees exactly where the ground is, and he also sees whether he under-

stands practically what he has learned theoretically. In the same manner a cross may be put on the cable and tested for. In fact, the box furnishes 1,000 feet of telephone cable in which faults may be placed at will, at one or more of several accurately determined points. This is but one of numerous schemes to test a student's theoretical knowledge.

The following sheet of instructions issued to each student at the beginning of the year will convey an idea of what is expected of a student, and of the methods pursued.

INSTRUCTION SHEET ELECTRICAL COURSE

Department of Enlisted Specialists, Coast Artillery School.

The system pursued in this course requires the student to do the reading and study necessary to solve the problems. The student will then go into the testing room and examine all machines and instruments that will make the answer clearer. The required experiments will then be carefully performed. Diagrams, and data will be neatly entered in the notes in ink. A brief answer will be entered in the notes after each question, in ink. The questions will be taken in regular order as nearly as possible.

The note-books are for the benefit of the individual student and the answers to the questions will not be checked or marked by the instructors, or officer in charge. The note-books will be inspected occasionally during the year, and it is not expected that any student will be found with a note-book lacking in brief, but complete answers, or in neatness. In case of difficulty during study or experiment, the student will consult the Instructor, but not until reasonable effort has been made to overcome the difficulty without assistance.

Laboratory apparatus will be used freely during study and discussions. The student will be particular not to waste time trying to understand a book description of a machine or apparatus when he can go into the testing room and take apart and examine the apparatus itself. If any question arises in the study that can be solved by an experiment, make the experiment. Sufficient experiments and practical work are required in this list of problems to illustrate most of the fundamental principles. A student should, however, consider himself at liberty to try any experiment that will make the principles clearer to him. If there is any possibility that the student may injure the apparatus used, through not thoroughly understanding its proper use, an instructor should be consulted before any switches are closed.

In making experiments involving the operation of machines, data sheets will be prepared and diagrams drawn showing circuit breakers, switches, etc. A brief statement of the purpose of the experiment will be made. The instructor's O. K. will be required on data sheets, diagrams, and circuits. After the experiment is completed the student will make a brief statement of the practical value of the experiment, and the instructor's O. K. will be required to show that the student understands what he has done. In drawing diagrams of circuits, use the conventional signs shown on the sheet issued.

No memorizing is required. A practical working knowledge is sought, and every effort should be made to make a practical test of any theoretical knowledge gained. Practical examinations will be given from time to time.

For example, the student will be required to calibrate a wattmeter, locate a cable fault by the loop test, make a particular type of joint, measure resistances by certain methods, connect up certain machines, etc., all in the presence of the instructor. There will be a time limit and a scale of marking for each of these tests. The proficiency of each man will thus be determined by a series of tests to show whether he can practically apply the theoretical knowledge gained. Written examinations will also be given from time to time.

The student will be marked not only upon the result of the examinations, but also upon his thoroughness, self-reliance, and ability to produce the required results. There will be one mark at the end of the school year, summing up the officer-in-charge's estimation of each man in regard to the qualities mentioned above. The master electrician instructing in this department, will also mark each man at the end of the school year upon the practical ability shown in the work to which the student has been detailed. Marks will be given for theoretical knowledge and practical ability pertaining to the machine shop, boiler room, engine room, the wiping of joints, etc. These marks will be given certain weights, and the man's standing will be determined therefrom. All marks will be kept posted on individual charts in the section room together with an explanation as to how to figure one's standing from these data. This will enable the student to know at all times his class standing. A mark of 1, 2, or 3 will be given each student at the end of each week to show whether his work is considered excellent, as indicated by 1, satisfactory, as indicated by 2, or unsatisfactory as indicated by 3. These marks, (1, 2, 3,), will have no numerical weight in figuring the final standing of students.

Each student will be required to visit and make a report upon each of the following power plants at some time during the year. The report should be brief, but should show clearly the kind of apparatus used, the general condition and efficiency of the plant, and the reasons for the efficiency or inefficiency of operation, as judged by the student.

List of Power Plants to be Visited and Reported Upon

1. All power plants and transformer stations at Fort Monroe and Fort Wool.
2. The power plant at the Chamberlin Hotel.
3. The power plant at the National Soldier's home.
4. The Norfolk & Portsmouth Traction Co's. power plant at Brambleton.
5. The Newport News & Old Point Electric Railway's power plant at Hampton.

There is much work to be done, and each student should proceed as rapidly as possible, with due regard to thoroughness.

Fig. 2 shows the excellent class room and the conditions under which the students do their studying. Fig. 3 shows the testing room in which the practical work is done. None of the machines and instruments are permanently attached to foundations, switchboards, or tables. Thought and ingenuity have been expended to allow the utmost flexibility in the use of apparatus. All machines are on rubber-tired rollers and

can be moved at will to any part of the room. Flexible couplings are used so that any machine can be directly coupled to any other with a minimum of trouble. Toe pieces and clamps are provided so that a machine can be quickly raised off the rollers, levelled up, and, if necessary, clamped to the floor. The switchboards have no instruments, or switches, permanently attached and are on rubber-tired rollers so that they can be conveniently moved to wherever needed. The instruments, circuit breakers, and switches are fastened to boards with hooks

Fig. 2.

at the back so that they can be conveniently attached to, or detached from, the wall racks or the switchboards. This scheme allows of greater freedom in the use of apparatus and also compels each student to do original work in the use of instruments and machines. He must rig everything for himself. Nothing is cut and dried to be learned by rote.

Fig. 4 illustrates what is meant by the flexibility mentioned above. After the test shown in the figure is completed, all leads will be disconnected, all instruments hung on the wall, the machines uncoupled, and machines and switchboard wheeled

FIG. 8.

out of the way. Whoever makes a similar test will need to know how to make proper connections. They cannot depend upon what has been done by other students.

Fig. 5 shows students at work learning joint wiping. The coast artillery has heretofore been compelled to hire experts from the outside to do this work at from $4.00 and upward, per day. Now, no electrician sergeant completes the course who cannot do this very necessary work satisfactorily.

In determining the proficiency of students, the examinations are practical. For example, the students have just now com-

Fig. 4.

pleted the course in gas engines. Before the examination the men were given a set of practical questions upon which they were to be examined. No restrictions were placed upon how they might obtain their information. The more they acquired the better. Each man was taken in turn to the gas engine by an instructor, and for about a day, the student explained all he knew about the machine, running it, adjusting the carburetor, setting the timer, explaining the oiling system, etc. At the end of the day there was little question but what the student was thoroughly examined, and but little chance that a student

who passed could not give reasonable satisfaction in running a gas engine. This is typical of all final examinations. A man's character and soldierly qualities enter largely into the final estimate of his standing.

An excellent wireless set has recently been received at the school and a course in this subject will be added to the list of things taught. Several additional months will probably be allowed for this course in wireless.

It is believed there is no other place in the world where a student whose early opportunities have been slight, can gain

Fig. 5.

so much valuable, practical knowledge in so short a time. The eagerness with which the students apply themselves and the long hours of labor that they voluntarily put in outside of the hours required, indicate that the government is not wasting money expended in this direction.

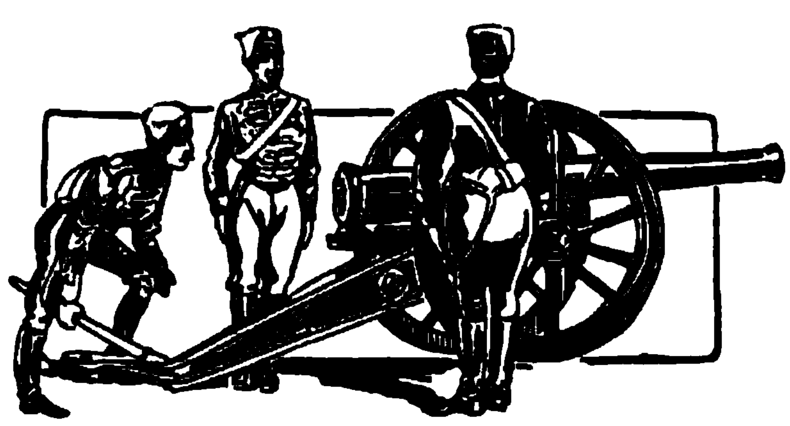
In arranging the course of study, in selecting text books and apparatus, and in adopting methods and schemes of instruction, the principal technical schools and electrical manufacturing plants have been visited and studied. It is believed that the school is at present thoroughly up-to-date, and that

in proportion to the number of men under instruction, the equipment for electrical instruction is equal in quantity, quality, and serviceability to that of the foremost technical schools of the country. To satisfy the present needs of the coast artillery and to prepare for any future needs by keeping thoroughly up-to-date is part of the policy of the course. Instructors and students consult the most recent standard books, the standard technical journals, the bulletins of the foremost electrical companies, government bulletins, catalogs and advertisements, in order not to miss any advance that may be made in electrical science.

It is the policy of the course to gain information from artillery engineers and from the electrician sergeants themselves as to whether the Electrical Course meets the needs of the service. It is intended to send every year a letter to each artillery engineer and to each master electrician requesting a brief criticism of the course as evidenced by the work of the electrician sergeants. These criticisms will be used as a basis for improving the course of instruction.

One of the best guarantees we have that the school will not stand still, but will progress with the rapidly advancing science of electricity, is the eagerness with which the especially selected noncommissioned officers who constitute the permanent instructors, grasp at every opportunity to gain additional knowledge, and the interest with which they follow every advance in electrical science. It is believed that a policy of sending these instructors to important electrical manufacturing plants once a year would be an excellent investment for the government. The one case in which this was tried during the past year proved of very great value to the school.

It is believed that the corps can depend upon all graduates from the course having a thorough knowledge of electrical engineering as applied to the coast artillery. It is further believed that the school furnishes to the corps a body of competent electrician sergeants who are ambitious, reliable men and excellent soldiers.



A PROPOSED FIGURE OF MERIT FOR COAST ARTILLERY TARGET PRACTICE

By Major WILMOT E. ELLIS, Coast Artillery Corps

The fundamental basis of a figure of merit is the percentage of hits, but in order to secure compensation for varying conditions and reference to a convenient standard, it becomes necessary to introduce other factors. The varying conditions are those relating to the rapidity of fire, and the difficulty of hitting the target, owing to its distance, speed, and direction of motion with respect to the line of fire.

The distance, speed, and direction of travel of the target may together be called "target conditions." In figures of merit heretofore used, only one of the target conditions has been recognized, viz., the distance of the target from the battery. This element has not entered directly, but the "probability of hit" introduced is an implicit function of the range. It is believed feasible and equitable to make proper allowance for the other two conditions,—the speed and the obliquity of the course.

The following is the general formula proposed:

$$M = \frac{C\,N\,S^{x} f\,(I)}{N'\,P\,T}$$

in which M = figure of merit.

C = a constant to be determined for each type of mount.

S = speed of target in yards per minute.

x = an exponent,—to be determined.

f (I) = the "obliquity function,"—a function (to be determined) of the angle between the normal to the line of fire and the course of the target.

N = number of hits.

N′ = number of shots fired at the practice.

P = probability of hitting.

T = corrected time of series in seconds.

No elaborate argument is necessary to demonstrate that the difficulty of hitting increases with the speed of the target. The minimum speed now allowed is 4 miles per hour, and a maximum, rarely exceeded, is 12 miles per hour. Let us consider two companies firing at the same mount under identical conditions, except as to speed of target. The first company fires at a target making 4 miles per hour, and the second, at a target making 12 miles per hour. What per cent. increase in the figure of merit shall we give the second company? This increase cannot be absolutely determined. One might argue for 6 per cent., another for 13 per cent. It is all a matter of judgment. Whatever the ultimate decision might be, the allowance desired could be made by giving a suitable value to x. Ten per cent. appears to be a fair allowance, and this is tentatively taken as the basis. We then have:

$$1.10\ (4)^x = (12)^x$$

whence $x = .087$. In order to facilitate computation, .09 will be taken as the value of x. This corresponds to an increase of 10.4 per cent. This value of the exponent of S gives fairly equicrescent values for intermediate speeds; 6 miles corresponding to 3.7 per cent. and 8 miles to 6.4 per cent.

The most favorable course is one that is perpendicular to the line of fire, and the most unfavorable is one that makes the least angle consistent with safety to the tug. This limit has never been fixed in orders, but might well be taken at 70°. The writer has occasionally noted ricochets to the left during the last two years at gun firing in the New London District, and finds, by inquiry among tug personnel, that a reduction in obliquity below the minimum specified does not meet with favor.

One part of the obliquity credit is strictly a matter of equity, and not a matter of opinion at all. The length of a gun target available for hitting falls off directly as the cosine between the course and the normal to the line of fire at the target. To compensate for this reduction alone, the obliquity factor would be secant I. For the maximum of 20° assumed, the available length of a gun target would be reduced by 6 per cent.

It is believed that something more than a mere credit for diminished length of target should be allowed. For an oblique course, both deflection and range change more rapidly as the obliquity increases. For obvious reasons, we should be generous in allowing for such conditions. Any additional credit for obliquity may be given by assigning a suitable value to the expo-

nent of secant I. 13.3 per cent. (including allowance for reduced length of target) is proposed for the maximum obliquity of 20°. 13.3 per cent exactly is taken so as to make the exponent of secant I a whole number, 2. ($\text{Sec}^2\ 20° = 1.133$.) The credits for smaller obliquities are considerably less than the corresponding ratio of the angles, as should be the case. The factors for 0°, 5°, 10°, and 15° are respectively 1, 1.01, 1.03, and 1.07.

Considering the speed and obliquity factors together, it will be seen that in passing from the most favorable conditions for a good record—target moving at 4 miles per hour perpendicular to the line of fire—to the most unfavorable—target moving at 12 miles per hour at an angle of 70° with the line of fire—the figure of merit is raised 25 per cent.

$$100\ (1.104 \times 1.133 - 1).$$

The next question to consider is: How shall the inclination of the course be determined, as this element is different for each shot? It would seem best to measure the obliquity for the first shot only, as this marks the epoch that commits the battery commander to a particular course, and his arbitrary corrections are based mostly upon observations at the beginning of the course. If the firing is interrupted, the obliquity should be taken for the first shot of each resumption, and the mean of all obliquities used. The only alternative would be to take the obliquity for each shot. The extra work involved in calculating the figure of merit on such a basis would scarcely be justified.

The application of "target conditions" to mortar figures of merit may require some discussion. In the first place, the target being a hypothetical circle, there is no absolute correction for diminished length. Again, as mortar firing is based upon predicted positions of the target, it might appear, on first consideration, that the direction of motion and the speed of the target would make no material difference. Such, however, is not the case. No target can maintain a strictly right line course, and its departure from its predicted position will increase with the speed. To put a target going 12 miles per hour on an equality with one going 4 miles per hour, the predicting intervals in the two cases should be in the ratio of 1 to 3. Moreover, as obliquity increases, the corrections based upon observations of fire, both for deflection and range, will require more alertness and judgment on the part of the battery commander. If he elects to make no corrections, the dispersions

will be greater than when the target is travelling under more favorable conditions. For these reasons, as well as for the sake of uniformity, the use of a figure of merit for mortars, of the same form as for guns is favored.

The speed of the target is given in yards per minute. This element can be taken directly from the plot of the course by measuring at the beginning of the course the distance between five successive plotted positions (for an observing interval of 15 seconds). Conversion of speed measurement into miles per hour involves a calculation that might introduce error, and the information, after it is obtained, has no practical value.

Let us now consider the other factors in the proposed formula for the figure of merit.

N/N′ is the percentage of hits. If the same number of shots for a given mount are fired each year, the factor N′ can be evaluated.

P, the probability of hitting, may, for guns, be taken from tables published each year. As no probability tables for mortars have yet been published, P, for mortars, must for the present be taken as unity. Strictly speaking, the assumption is made that the probability of hitting with mortars at all ranges is the same, and the undetermined constant is absorbed in C.

T is taken in seconds, as being more convenient than minutes. The expression of T in minutes frequently results in the introduction of an irreducible decimal, involving extra calculation and the possibility of introducing an error into the computation.

No absolute figure of merit can be established, because the target conditions and the time of firing a series are variable. A yearly standard, however, on the basis of 100 can be established as follows. The company that leads the list for each mount will be given two figures of merit, one determined by calculation for the season concluded, and the other a maximum of 100 for the ensuing season. In order to determine the value of the constant C for the ensuing year, place M equal to 100, substitute in the general expression the values of the several factors as obtained from the record of the leading company for each mount, and solve for C. It would be a good plan to publish the factors entering the equation for each mount, so that in every case it may be determined why the record was not reached, or was surpassed, as the case might be.

Writing the formula for the figure of merit in its final form, and applying logarithms, we have:

$\text{Log } M = \log C + \log N + .09 \log S + 2 \log \sec I - (\log N' + \log P + \log T)$

The following advantages are claimed for the figure of merit proposed in this discussion:

1. Battery commanders will be encouraged to fire under more difficult "target conditions", thus conducing to efficient war training.
2. The best results each year are made the standard of excellence for the ensuing year.
3. The generally accepted mark of 100 is adopted as the standard. The value obtained for the figure of merit will scarcely ever be more than 25 per cent. greater than the percentage of hits, and the figure of itself will express comparative excellence.
4. All companies, irrespective of the mounts to which they are assigned, can be graded on one list as to efficiency at target practice. The emulation that would result in the District, the Division, and the Corps at large, would be most beneficial to the Coast Artillery service.

NIGHT SERVICE ARTILLERY PRACTICE

BY CAPTAIN FRANK T. HINES, COAST ARTILLERY CORPS

Target practice results of the Coast Artillery are becoming more gratifying each year and the accuracy of practice for the year 1910 was such that had the firing been conducted against a modern battleship, practically every shot would have hit some part of the target. The ranges are increasing each year and it is extremely doubtful if the fortifications will ever have an opportunity to actually engage an enemy's fleet in broad daylight.

This fact together with the duties assigned to companies of the mine defense, make it not only desirable but necessary that these organizations hold service practice at night.

There are forty-three companies of coast artillery assigned to the mine defense. These companies are assigned to rapid fire batteries, and it is their duty to protect the mine fields against the raids of torpedo boats and destroyers, and to keep other small swift vessels from entering the harbors at night.

Night firing was held with Semple tracer ammunition in six harbors during 1909 and by all companies assigned to the mine defense during this year, 1911.

The report of the Chief of Coast Artillery, 1911, contains the information that excellent results were obtained with heavy guns at Manila in night firing. These guns fired at long ranges and in one case made three hits out of four shots at about 5000 yards range with 12-inch rifles.

A recent report of night firing with 12-inch guns at Fort Mills, Corregidor Island, shows that four hits were made out of six shots on a material target with 30 x 60 foot screen, which was moving at a rate of 8½ miles per hour at a range of about 4½ miles from the battery firing.

With such progress being made it is not considered radical to predict that the next few years will witness night service practice in all of our harbors, where such can be held, with not only rapid fire, but all calibers of guns and possibly mortars.

There can be no better test of our fire control and search-

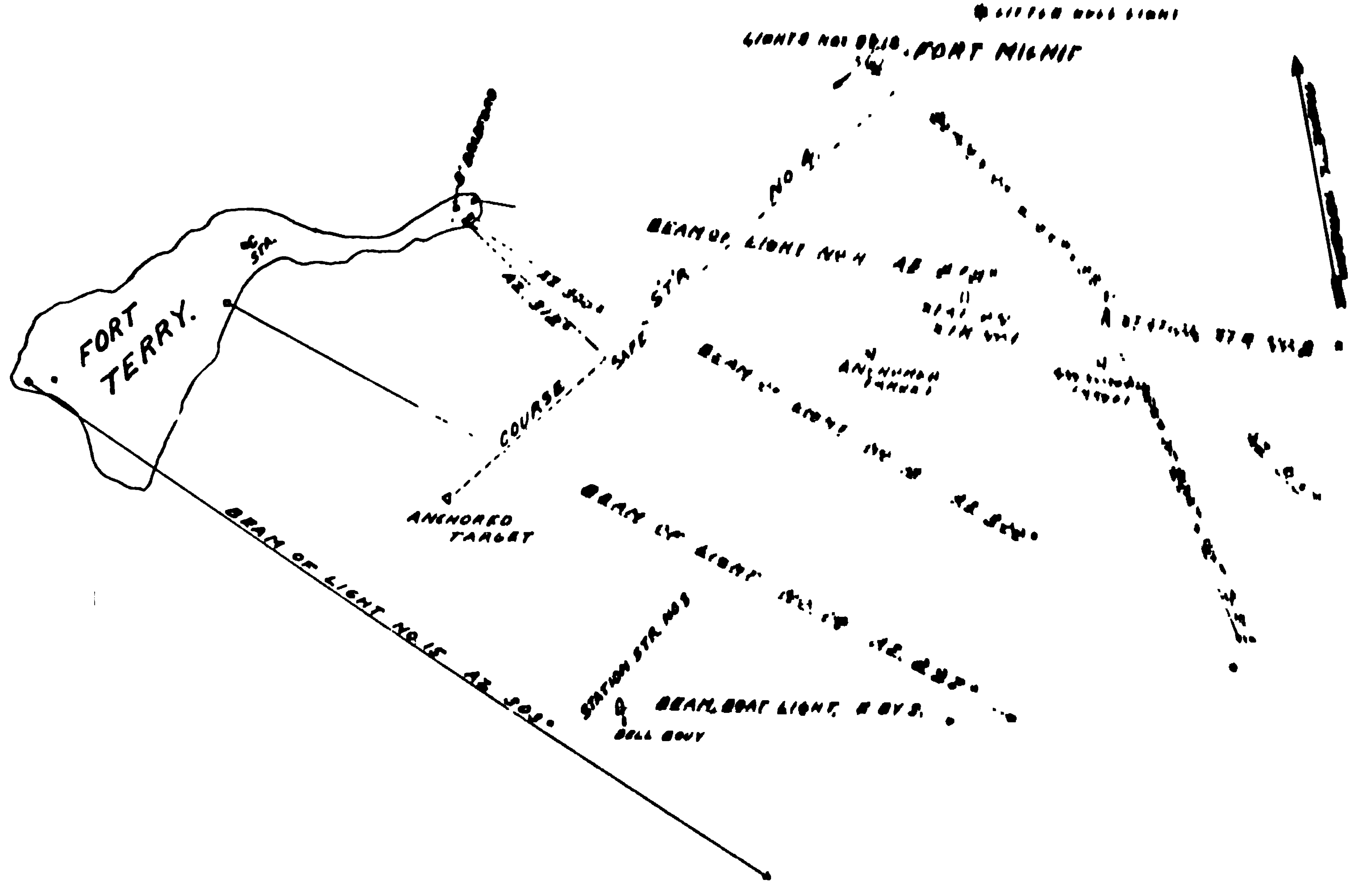


FIG. 1.

Chart showing stations of steamers and setting of searchlight beams for night firing, Artillery District of New London, September 15, 1911.

light installations than night firing. The difficulties of properly illuminating the target, patrolling the field of fire before practice and insuring safety of same during the practice, are new and interesting problems.

How these problems have been solved in one artillery district on the Atlantic coast may prove of value to those required to conduct night firing and of interest to all.

It should be understood that district commanders are held responsible that shipping and persons on adjacent shores are not endangered by this firing and are required to exercise every possible precaution for safety.

Fifteen and five days before the scheduled date of firing, the following notices were sent out to all Postmasters, ships' chandlers, etc., in the vicinity:—

NOTICE

Notice is hereby given to all shipping interests that firing of three-inch guns will take place at Fort Terry, N. Y., on NIGHT OF OCTOBER 31, 1911. The field of danger will be on the waters east of Plum Island and north of Gardner's Island.

W. C. RAFFERTY,
Colonel, Coast Artillery Corps,
Commanding.

The general order for carrying out Night Service Practice in the Artillery District of New London, in which 14 companies satisfactorily held night service practice during the past year, is as follows:—

HEADQUARTERS
ARTILLERY DISTRICT OF NEW LONDON

GENERAL ORDERS, No. 28 — FORT H. G. WRIGHT, N. Y., SEPTEMBER 8, 1911.

General Orders No. 14, c.s., these headquarters, is hereby revoked and the following substituted therefor.

The following instructions are issued and will govern during Night Service Artillery Practice in this District.

I. SEARCHLIGHTS

a. From dark until conclusion of practice for the night, searchlight beams will be set as follows:-

No. 9, Fort Michie, azimuth 315°
" 10, Fort Michie, " 315°
" 11, Eastern end Fort Terry, azimuth 278 degrees
" 12, Eastern end Fort Ferry, " 30 "
" 14, Near M' Fort Terry, " 297 "
" 15, Near Plum Island Light, " 303 "

Steamer No. 2, South x East (magnetic). Steamer No. 3, East x South (magnetic).

b. The lights specified in section a, are safety lights. The beams will be fixed and laid horizontally. Each beam will be given a frequent oscillating motion upward about a degree, and then back to the horizontal position.

c. Light No. 13 will be used for illuminating the target. When not actually so employed, it will be elevated about 30 degrees directly above the target.

d. Light No. 12 will be the signal light, but for signalling it will not be removed from its fixed position. When necessary to use the light for this purpose the shutter will be placed in position, and will be removed as soon as signalling is completed.

II. POST AND DUTIES OF STEAMERS

a. Steamer No. 1, chief patrol boat. Station NW x W 1-2 W to searchlight at eastern end of Fort Terry and N NE 1-2 E to Little Gull Light. From B′ Bradford azimuth 288 and about 4300 degrees yards from same.

Personnel and Equipment.

Chief Patrol Officer and one assistant patrol officer.

Signal detail—3 men (2 of whom are expert signalmen).

Safety observers—6 men. (Being two reliefs.)

One member Hospital Corps detachment.

1 Fire Commander's telescope (mounted).

4 field glasses. 36 Very lights, red. 36 Very lights, green. 2 Very pistols. Copy of this order. Copy of signal order.

b. Steamer No. 2, assistant patrol boat. Station N x W 1-4 W to Little Gull light and on line Constellation Rock, Orient Light; from B′ Bradford azimuth 280 degrees and about 7700 yards from same.

Personnel and Equipment.

Assistant patrol officer.

Signal detail—3 men (2 of whom are expert signalmen).

Safety observers—6 men. (Being two reliefs.)

Searchlight detail—Electrician Sergeant and two men. One member Hospital Corps detachment.

4 field glasses. 18 Very lights, red. 18 Very lights, green. 1 Fire Commander's telescope (mounted). 2 Very pistols. Copy of this order. Copy of signal order.

c. Steamer No. 3, assistant patrol boat. Station near gas buoy, close to Fort Tyler.

Personnel and Equipment.

Assistant patrol officer.

Signal detail—3 men (two of whom are expert signalmen).

Safety observers—6 men. (Being two reliefs.)

Searchlight detail—Electrician Sergeant and two men. One member Hospital Corps detachment.

4 field glasses. 18 Very lights, red. 18 Very lights, green. 1 Fire Commander's telescope (mounted). 2 Very pistols. Copy of this order. Copy of signal order.

d. Steamer No. 4, towing targets.

Personnel and Equipment.

Tug officer.

Detail to handle target.

Signal detail—3 men (2 of whom are expert signalmen).

Safety observers—3 men.

Searchlight detail—Electrician Sergeant and two men.

One member Hospital Corps detachment.

2 field glasses, 36 Very lights, red. 36 Very lights, green. 2 Very pistols. 300 feet towing rope. Red streamer.

Copy of this order. Copy of signal order. Copy of C.A.M., No. 11, 1910.

Station and starting point of Steamer No. 4, on line from flag staff at C Station to gas buoy and NE x E to Little Gull Light.

From B′ Bradford, azimuth 359 degrees. Range, 2900 yards.

e. Auxiliary Steamer No. 4, (for towing targets), same equipment as Steamer No. 4.

Station of Auxiliary Steamer No. 4, near anchored target at starting point of steamer No. 4 and between same and beam of No. 14 Light.

f. Steamer No. 5. Dispatch boat for Steamer No. 1.

Personnel and Equipment.

Tug non-commissioned officer. Safety observers, 3 men. 1 field glass.

g. Steamer No. 6. Dispatch boat for Steamer No. 3.

Personnel and Equipment.

Tug non-commissioned officer. Safety observers, 3 men. 1 field glass.

III. DUTIES

1. Chief Patrol Officer

a. All patrol and dispatch boats will be under the direct orders of an officer detailed from these headquarters, and designated "Chief Patrol Officer." The senior officer or non-commissioned officer in charge of each patrol or dispatch boat will, immediately after being detailed, report to the Chief Patrol Officer for orders.

b. The Chief Patrol Officer is responsible for the efficient patrolling of the field of fire, for safety on the water during all night practice, for communication among boats, and between boats and shore, for marking the positions of Steamers Nos. 1 and 2 by suitable illuminated buoys before dark on the day when any night practice is to be held.

2. Post Commanders

a. The Commanding Officer, Fort H. G. Wright, N. Y., is charged with furnishing the personnel and equipment for Steamers Nos. 1, 2 and 5.

b. The Commanding Officer, Fort Terry, N. Y., is charged with:-

1. Furnishing the personnel and equipment for Steamers Nos. 3 and 4, and Auxiliary Steamers Nos. 4 and 6.
2. The control of Steamer No. 4 and Auxiliary Steamer No. 4.
3. The marking of starting point of practice course by an illuminated buoy or target.
4. The operation of all searchlights at Fort Terry and Fort Michie.
5. The detail of instructions to personnel for signalling, telephoning and watching at Forts Terry and Michie.

6. Marking the parapets of Battery Dalliba at the azimuths of the safe sector of fire, namely between 300 and 312 degrees.

7. The maintenance of communications on shore and from shore to boats.

8. Detailing of timekeepers and such other assistants as the umpire may require.

9. Furnishing such assistants as may be required by Fire and Battery Commanders under the provisions of orders regulating the general conduct of service target practice.

IV. GENERAL REGULATIONS FOR THE PRACTICE

a. The following will be the normal routine:

Boats being in position, and all ready on shore. Shore signal light sends signal No. 1, and displays three green Very lights. Light No. 1 is directed on target. If all is safe, Steamers No. 3, 2 and 4 in order named display three green Very lights. Steamer No. 1 then signals No. 1, and displays three green Very lights. Thereafter, in the absence of the Danger Signal from any boat, it is understood that as long as any firing lasts, the status SAFE obtains afloat.

Steamer No. 4, displays red streamer. Shore signal light signals No. 2. Steamer No. 4, starts on course running on Little Gull Light at about 5 knots per hour. When Steamer No. 4 has passed through beam of No. 12 light and target is just entering same, she will signal "Danger", lower red flag, and turn without the transmission of turning signal from shore, return towards starting point and watch for further signals.

b. Danger noted or obtaining for any boat will be indicated by the display of three red Very lights in quick succession, and the transmission of "D" (danger) signal and three red Very lights will be repeated by Steamer No. 1, and shore light. Signal will be repeated until shore acknowledges.

c. When the "danger" shall have passed, the boat concerned will display three green lights.

Steamer No. 1 and shore will repeat signal No. 1 and display green lights.

d. The signal DANGER having once been given, the status DANGER will obtain both ashore and afloat, until the interchange of signals prescribed in par. (c) above has been affected, when status SAFE will obtain continuously unless DANGER is again signalled.

e. Signals from shore will be sent to Steamers Nos. 1 and 4 only. Unless the call letter of other steamer is used, it will be understood that all signals will apply to Steamer No. 4 only. For signals between Steamer No. 4 and shore no call letter will be used.

f. For signalling by boats, the whistle will always be used and the searchlight also when practicable.

g. "Practice ended for the night" will be indicated by sending signal No. 11 from shore and the elevation of all searchlight beams ashore for about one minute. After Steamer No. 1 acknowledges, all other boats will acknowledge and elevate lights.

h. All personnel will provide lunches and make arrangements for hot coffee if practicable.

i. All patrol boats will anchor at the positions indicated under 3, above. (It may be necessary to anchor fore and aft.)

The anchoring positions of Steamers Nos. 1 and 2 and starting point of the course for moving target will be marked by anchored skeleton pyramidal targets, provided with proper illuminating lights.

j. No enlisted men except the prescribed details will be allowed east of the line north and south through the entrance to Battery Stoneman. (See blue print attached.)*

BY ORDER OF COLONEL RAFFERTY:

FRANK T. HINES,
Captain, Coast Artillery Corps,
Adjutant.

In carrying out the above order, a memorandum in the form given below was sent to the Chief Patrol Officer and District Quartermaster early each day, so that the Chief Patrol Officer could issue any additional instructions to the personnel under him, and that the District Quartermaster could give the necessary orders to the district boats.

MEMORANDUM FOR CHIEF PATROL OFFICER

Fort H. G. Wright, N.Y., ... 1911.

The program for this date will be as follows:—

1. Steamer No. 1. (....................).

Leave New London at 5:30 p.m., proceed to Fort H. G. Wright, N. Y., report to Chief Patrol Officer, take details on board, proceed to station and anchor. Upon signal "close practice" return details to Fort H. G. Wright and proceed to New London.

Steamer No. 2. (....................).

Report to Chief Patrol Officer at Fort H. G. Wright, N. Y., at 5:40 p.m. Leave Fort H. G. Wright, N. Y., with details on board at 5:45 p.m. Patrol field until 7:15 p.m., then take station and anchor. At signal "close practice" return details to Fort H. G. Wright and proceed to New London.

Steamer No. 3. (....................).

Report to Assistant Patrol Officer at Fort Terry (South Dock) at 6:00 p.m. Take details on board, patrol field, proceed to station and anchor by 7:30 p.m. At signal "close practice" return details to south dock, Fort Terry, and proceed to New London.

Steamer No. 4. (....................).

Report to Commanding Officer, Fort Terry, for duty towing target at 6:30 p.m.

Auxiliary Steamer No. 4. (....................).

Report to Commanding Officer, Fort Terry, at 6:00 p.m., for duty towing targets. This boat will leave the south dock at 6:30 p.m. with four (4) 10 x 24 targets and proceed to starting point of course as indicated in General Regulations for Night Firing.

* See Fig. 1.

Steamer No. 5. (...................).
Report to Chief Patrol Officer at 5:45 p.m.

2. Instructions should be given to the Assistant Patrol Officer on Steamer No. 3, to cause the searchlight on that steamer to rove from east to southeast instead of remaining stationary as required by Night Firing Regulations.

By order of Colonel Rafferty:
Frank T. Hines,
Captain, Coast Artillery Corps,
Adjutant.

The auxiliary steamer, No. 4, referred to in the above order, was used to take out the necessary number of 10 x 24 targets, to be used on any night, and hold them at the starting point of

Fig. 2.
Target after night practice of 132nd Company, Coast Artillery Corps.
16 hits out of 18 shots.

the course. In order to facilitate picking out the targets at night, each 10 x 24 target was marked in large black figures in two places in the vertical white sections and in large white figures on the float, with the number corresponding to the number of the company firing.

The method used to change targets at the starting point is of interest. When Steamer No. 4, the towing steamer, had passed over the course and a company had completed its series, it would return to the starting point, passing by the auxiliary steamer near enough so that the target detail aboard that steamer

could reach the target being towed. A heaving line was then made fast to the target, the towing rope removed from the bridle and transferred to the target marked for the next company in order of firing. This operation required a very short time and from the time Steamer No. 4 made the turn back to the starting point until the target was again on the course never exceeded thirty minutes and in some cases was as low as twenty minutes.

How well the scheme outlined worked out can best be judged by the results obtained on September 16, 1911; on this date the starting signal was given a few minutes after 8:00 o'clock p.m., and the last company finished firing at 11:00 p.m.—during the interval five three-inch companies fired eighteen shots each from the same two-gun 3-inch R. F. battery.

A summary of the results obtained from the night firing held in this district during 1911, is as follows:—

Company	Date	Cal. gun	Practice	No. hits	Time min.-sec.	Figure of merit
14th	Oct. 31	3-inch	4th	9	5–50*	0
54th	Sep. 16	3 "	1st	3	1–23	2.53
100th	Sep. 16	3 "	4th	10	1–48	21.60
129th	Nov. 1	3 "	4th	14	1–53	40.47
131st	Sep. 18	3 "	4th	8	1–31	16.41
132nd	Sep. 18	3 "	4th	16	1–32	64.92
133rd	Sep. 18	3 "	4th	8	2–15	6.06
135th	Sep. 16	3 "	4th	2	1–56	.72
136th	Nov. 1	3 "	1st	13	1–44	37.90
137th	Sep. 16	3 "	4th	3	1–42	2.62
157th	Sep. 18	3 "	3rd	16	1–43	57.99
165th	Sep. 16	3 "	1st	10	3–53	.01
104th	June 22	3 "	4th	9	2–40	11.82
139th	June 22	3 "	3rd	1	1–52$\frac{3}{5}$	.21

* Excessive time due to interference of rain.

The experience gained by all in conducting Night Service Practice cannot be overestimated. The opportunity given a battery commander to observe the fire of his battery under conditions that are more apt to obtain than any other in actual service must be admitted as most valuable. The gun pointer soon becomes accustomed to the blinding glare which at first blanks his entire vision and the observers and searchlight operators are given a test in efficiency which cannot be gained by an equal amount of practice in any other way.

To witness night service practice is to be more fully impressed with the necessity for the development and improvement of a satisfactory shell tracer. With shell tracers that function prop-

erly there is no question as to where the shot strikes. A battery commander can follow each projectile from the time it leaves the muzzle of the gun until it makes its first ricochet. The little blink which occurs at the target, clearly indicates to him when the projectiles are reaching their mark.

With perfect tracer ammunition, along with our present excellent fire-control and searchlight installation, little success will attend the effort of small craft at night, within the range of our modern secondary armament.

It would seem to be time to extend our efforts next to night firing with the intermediate and primary armaments.

DEFECTS IN TELESCOPES

BY CAPTAIN GLEN F. JENKS, ORDNANCE DEPARTMENT

The defects in the optical parts of telescopes are: Those inherent in the optical elements, and those resulting from deterioration. No optical instrument is theoretically perfect. The science of geometrical optics is an approximate science rather than an exact science. The practical optician is not only limited by the nature of the science but is more closely limited by the difficulties of manufacturing optical glass of the exact optical qualities desired. The practice in design and manufacture varies with the use to which the optical instrument is to be put. Thus inherent defects may be neglected provided they do not interfere with the proper use of an instrument. If the instrument is visual, there is no need of correcting defects which the eye cannot detect.

Defects of telescopes such as used by the service may reside in the objective, prism system or eye piece. The objective is the most important element. The principal inherent defects may be classed as: Chromatic aberration, spherical aberration, coma, astigmatism, curvature of the field, and distortion.

CHROMATIC ABERRATION

Ordinary white light which affects the retina of the eye is composed of light of various wave lengths, that is, of various colors. Light incident at a glass surface is refracted into the glass medium at an angle of refraction depending not only on the physical qualities of the glass and the angle of incidence, but also upon the wave length of the light incident. If the glass medium is a plate, the light resolved into its component colors at the first surface will be reunited at the second surface.

Thus in Fig. 1, let AB represent a pencil of white light from a distant object incident at a glass plate. Because the refractive power of the glass varies for different wave lengths the pencil AB is broken up or dispersed. The line BC_1 represents the path taken by light of the shorter wave lengths (the violet end of the spectrum) and the line BC_2 represents the path taken by the

light of the longer wave lengths (the red end of the spectrum). After refraction at the second surface the violet and the red light become parallel. Thus all rays appear to come from the same distant object. The net result of the passage of the light through the plate is a displacement of the image. In Fig. 1 it will be noted that rays C_1D_1 and C_2D_2 are parallel to AB but displaced in respect to it.

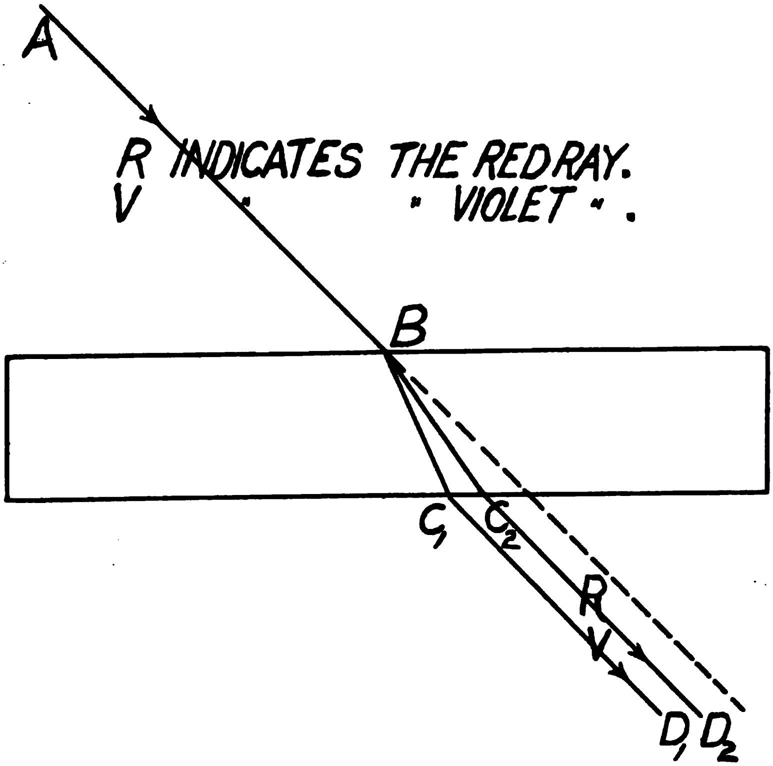


FIG. 1.

The action of both positive and negative lenses in dispersing light is shown in Fig. 2. Parallel incident light is dispersed into its elements and the light of various wave lengths is refracted in different degrees. Thus in the positive lens the red rays are brought to a focus at F_2 while the more refrangible violet rays are brought to a fucus at F_1. In the negative lens the violet rays are refracted more and appear to come from F_1, while the longer red rays appear to come from F_2. It will be noted that for a positive lens the violet rays (V) are inside the red

rays (R) while in the negative lens the relative position of the rays is reversed. The dispersive power of a lens is the difference between the refractive powers for different wave lengths of light.

Now if a positive and a negative lens are made of the same material and to the same focal length (equal refractive power) it is evident from the figures that the dispersions of the two lenses will neutralize each other. The effect of two such lenses

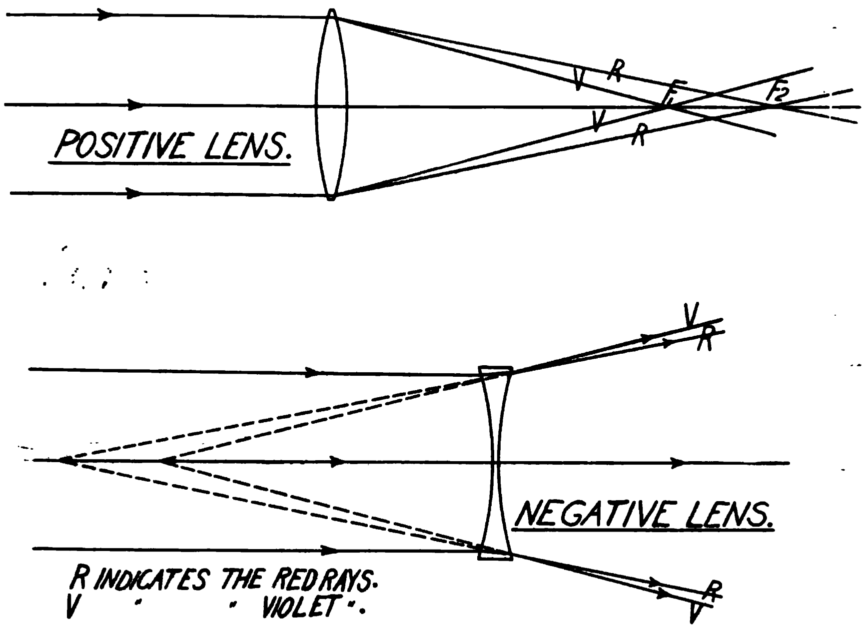


FIG. 2.

of small separation is the same as that of the plate glass described above.

However, glass is made of various chemical substances and varies greatly in its optical properties. The variations in its refractive powers are small in comparison with the variations in its dispersive powers. For example, crown glasses have low dispersive powers in comparison with their refractive powers, while in flint glasses this ratio is higher.

The refractive power of a positive lens (one that converges parallel incident light to a focus) may be represented by a positive quantity, say x. Likewise for a negative (diverging) lens, it may be represented by a negative quantity, say − y.

Let the dispersive powers be represented by ax and $-by$ respectively, a and b representing the ratio of dispersive power to refractive power. As stated above, the variation in x and y is small while the variation in a and b is comparatively large. Now suppose b is much greater than a; thus if

$$ax - by = 0,$$

then

$$x - y > 0.$$

That is, a negative lens and a positive lens of different glasses may be combined with each other in such a manner that the resulting dispersive power is zero, while the resultant refractive power is an integral quantity. This condition is shown in the diagram marked Fig. 3, in which the light dispersed by the first lens is reunited by the second lens while the refractive power of the second lens is not large enough to overcome that of the first lens. Such a combination is an achromatic lens. The difference in the position of F for different wave lengths of light is the chromatic aberration.

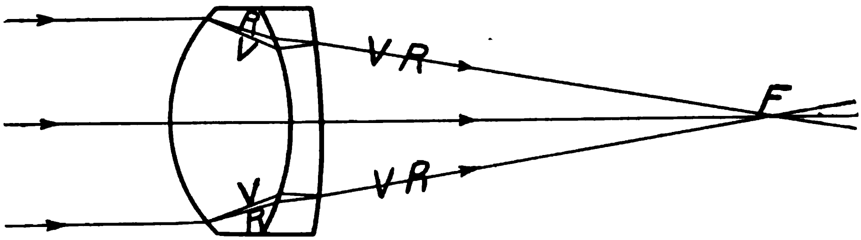


FIG. 3.

In the various types of optical glass obtainable, the relative dispersion for various wave lengths differ. With the types of optical glass ordinarily used, perfect correction for chromatic aberration can be made only for two wave lengths. For all other wave lengths there is a residual chromatic aberration which cannot be corrected. For a visual instrument the chromatic correction is made for the C and F rays, corresponding to orange-red and blue-green colors, respectively. The observable residual chromatic aberration uncorrected is principally of the yellow and violet rays. If a lens is not properly corrected for the C and F rays, a bright fringe, colored red or blue, will be formed on well defined details. In this case the chromatic aberration is termed "primary." If the yellow or violet fringes only are present the chromatic aberration is termed "secondary."

Primary chromatic aberration may be completely eliminated by the proper designing of an optical system. Except as noted below, secondary chromatic aberration is an inherent defect and after the selection of glass cannot be lessened by the optician. The amount present may, to a small extent, be lessened by the proper choice of types of optical glass.

A few types of glass have been manufactured, by the use of which it is possible to make color corrections for three different wave lengths, thereby practically eliminating all trace of color from the image. Such types of glass are not used for ordinary telescopes. The elimination of the secondary chromatic aberration is not so important as the improvement of other qualities. It is negligible in the ordinary telescope.

In an achromatic objective the C and F rays of light from an infinitely distant object are brought to a focus in one plane. This is accomplished by the use of a flint dispersive lens and a crown converging lens of the proper power. In thin lenses, the chromatic aberration is made independently of the curvatures of the surfaces, being a function only of the focal lengths. In the better class of objectives, thickness must also be considered.

In an eye piece, achromatism is effected by making the images formed by the various wave lengths of the same size rather than in the same plane. This is achromatism as to magnification. For an eye piece the size and not the position of the images for the various wave lengths is the important element. The eye is unable to distinguish the difference in the distance to the image providing all images of all colors of light are of the same size. In general, real images are made achromatic in respect to place and virtual images achromatic in respect to magnification. In an eye piece achromatism is sometimes accomplished by the separation of lenses, but ordinarily by the separation of lenses and the use of cemented combinations of crown and flint elements.

In the simpler systems the chromatic correction is made only for paraxial rays (those lying near the axis of the system), but in the larger and more complex systems the problem is complicated by the necessity of considering the chromatic aberration of image formed by pencils of rays oblique to the axis and the chromatic aberration due to the spherical aberrations. In a telescope system it will be noted that the center of the field of view is ordinarily more perfectly achromatic than the edge of the field. Again, a telescope objective is not achromatic

for all positions of the object. Calculations are based upon the object being infinitely distant, that is, for parallel rays of light. For the ordinary ranges the residual chromatic aberration is negligible.

The longitudinal primary chromatic aberration is the distance measured along the axis of the optical system between the image planes for the C and F waves of light. Likewise the longitudinal secondary aberration may be measured for the D ray (yellow corresponding to a sodium flame). For ordinary examination of objectives for chromatic errors a qualitative determination is sufficient. For this, select a dark, well defined object on a light background at as long a distance as practicable. If primary chromatic aberration is present, red and blue fringes will be seen bordering the images; if no primary chromatic aberration is present, the fringes will be yellow and purple. Separate determinations should be made for the central and outer zones of the image.

For quantitative determination of longitudinal chromatic aberration the positions of the image planes for light of wave lengths corresponding with the C and F rays are measured.

An eye piece may be tested for achromatism by using it as a magnifying glass in examining a sharply defined object for color fringes.

Prism systems used in erecting the image of a telescope are similar to plates of glass. Thus no correction for achromatism is required.

Spherical Aberration

Spherical aberration is the error in the positions of the images formed by pencils of light incident on the central or on the outer zones of a lens.

By the term "spherical aberration" is ordinarily meant what may be called direct spherical aberration. Comatic aberration, or coma, is a kind of spherical aberration. The first pertains to paraxial rays only, the latter pertains to oblique pencils. The theories of these aberrations are separately developed and it is customary and convenient to treat of them separately. As the correction for chromatic errors is made independently, only the value of the refrcative index for a single wave length of light is considered. This is taken for the D ray corresponding to the yellow light of a sodium flame.

Paraxial rays, which are from an object lying in or near the axis of an optical system, incident on the central zone of a system, come to a focus at a point. If rays from the same object incident on the outer zones are focused at the same point, the lens or system is spherically correct for direct pencils. If, however, the rays refracted by the outer zone of the lens or system are focussed nearer the system than the rays transmitted by the inner zone, the system is said to be spherically under corrected. Ordinary converging lenses are spherically under corrected. In a spherically over corrected lens the outer rays of a paraxial pencil are focused farther from the lens system. The diagram (Fig. 4) shows the path of rays refracted from the last surface

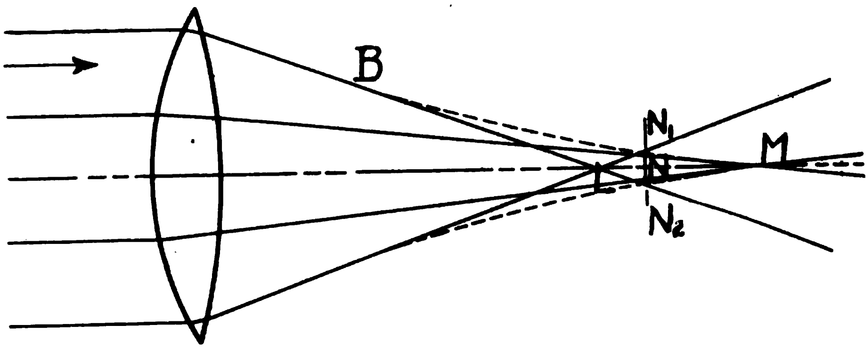


Fig. 4.

of a spherically under corrected lens. The direction of progress of the light is indicated by the arrow. Rays intermediate between the ones shown form the caustic BM. LM is the longitudinal spherical aberration.

N_1N_2 is the smallest circle through which all the rays from a given object pass and is called the least circle of confusion. This is the location of the image plane which is examined directly or indirectly by the eye. The amount of uncorrected spherical aberration permissible depends upon the size of the least circle of confusion which varies directly with the third power of the aperture of the lens system. It will also be noted that the permissible quantity of uncorrected aberrations will depend upon the power of the ocular.

The quantity of spherical aberration in a lens is a function of the focal length, the curvature of the surfaces and the refractive index of the material. The ordinary simple lens cannot be corrected to eliminate all spherical aberration. The uncorrected aberration depends upon the form. In text books the

biconvex lens is taken as an example of a lens with a minimum of spherical aberration. In this lens the surface receiving the incident pencil from a distant object has a radius of curvature equal to six times the radius of curvature of the other surface. In the case of an objective, spherical aberration may be eliminated by the use of a positive and a negative lens and by the proper choice of radii of curvature. It should be noted that in all optical calculations the direction in which the light wave progresses must be considered. A system designed for light incident at a given surface will give faulty results if light is permitted to enter from any other surface. This is the principal reason why lenses must be carefully marked to indicate the surface at which light is incident.

The amount of spherical aberration which may remain uncorrected in a good objective is very small. Ordinarily little trouble is experienced from it in small objectives. In the highest grade 3-inch objectives the uncorrected spherical aberration should not exceed a few thousandths of an inch.

In calculating or measuring the aberrations of an eye piece the direction of the pencil is taken in the opposite direction to the path through a telescope. Rays of light emerging from an eye piece in normal adjustment are parallel. Reversing the direction of light, parallel incident rays are brought to a focus. The separation of the lenses in an ordinary eye piece assist in reducing spherical as well as other aberrations.

To measure the longitudinal spherical aberration of a lens system, cover all but a small central zone of the lens and note the position of the image plane for a distant object, then cover all but the extreme outer zone of the lens system and note the change in position of the image plane. This difference in position of the image planes is the logitudinal spherical aberration. A reticule lies in an image plane when all parallax is removed. Thus the measurement may be easily made in any telescope with an adjustable reticule.

COMA

Coma is an aberration of oblique rays similar to the spherical aberration of paraxial rays (see Fig. 5). If oblique pencils incident at central and outer zones do not pass through a common point, a caustic curve is formed as in the case of spherical aberration, and coma is apparent. Coma appears as a light flare extending outward as a short tail of a comet from well

defined objects—thus its name. The condition for the absence of coma is identical with the sine condition, that is, equal magnification of the image formed by various zones of the lens. In lenses of very small aperture, good definition may be obtained by correcting it for paraxial rays only. For lenses of ordinary size the correction for oblique rays must be made; else in extreme cases the difference in magnification of the image formed by light from the various zones of the lens will cause an overlapping of the images and consequently a blurring.

Like spherical aberration, coma is a function of the refractive index, the focal length and the curvature of the surfaces. In photographic objectives the effect of coma may be reduced by stops. In a telescope system any stop which reduces the intensity of illumination cannot be tolerated. Therefore, the coma

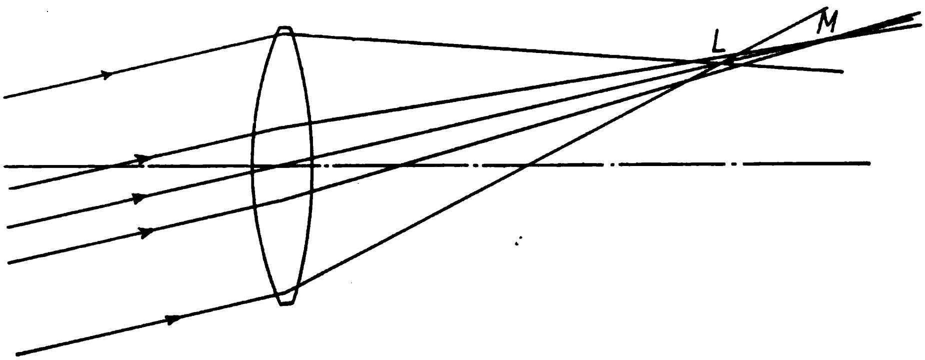


FIG. 5.

correction must be more perfect. Objectives, either doublets or triplets, can be calculated to eliminate both spherical aberration and coma. The focal lengths of the elements of the objective are fixed by the condition for achromatism and the curvature of the elements are fixed by the conditions for spherical and comatic aberrations. No other conditions can be fulfilled in the ordinary telescope objective.

The presence of comatic aberration in a telescope may be determined by focusing it on a small round white object (preferably after covering all but the central portion and the other ring of the objective), and noting whether any flare extends from the image. The outer zones of the field are most likely to be affected. The whole field should be examined. It may be measured quantitatively in the same manner as spherical aberration, except that objects in the outer zones of the field should be observed.

Resolving Power

A far more delicate test in determining the freedom from spherical and comatic aberrations, of an objective or of an optical system, is the measurement of its resolving power. The limiting angle of resolution of an optical system is the angle subtended by adjacent lines on a finely graduated plate, at the distance at which the separate lines are just visible to the eye with the aid of the optical system. Beyond a given distance the lines appear to run together or to fade away, and they can no longer be seen as distinct entities. For the test monochromatic light is employed. Sodium light is efficient and easily produced. It is necessary to use an ocular of sufficient power, so that the resolving power of the system is not limited by the least angle of vision. The angular separation of objects which can just be distinguished from each other by the ordinary eye is one minute. Thus the focal length of the eye piece should be such that the power of the telescope system formed should be at least twelve times the aperture of the lens tested, preferably more. Knowing the angle of resolution, the coefficient of resolving power of an optical system is calculated by the formula:

$$a = \frac{\varphi \upsilon}{\lambda}$$

in which φ is the angle of resolution, υ is the radius of aperture of the objective, λ the length of wave of light employed and a the coefficient of resolving power. The value of a for objects lying near the axis will increase with the quantity of spherical aberration present while for objects lying off the axis, the value of a increases with the amount of comatic aberration.

Theoretically the limiting value of a is .61. Practically smaller values are obtained in good objectives for both direct and oblique pencils. Although by formula a is independent of the focal length, yet if the focal length is less than about 8 times the aperture, larger values of a must be expected. In high grade objectives values of a as low as .525 are obtained.

It may be remarked that owing to the limitation in the value of $a = \frac{\varphi \upsilon}{\lambda}$, it is useless to increase the magnifying power of a telescope system for a given aperture of objective beyond a certain value. The condition for maximum intensity of illumination of the field, however, limits more closely the mag-

nifying power of telescopes intended for use under poor conditions of illumination.

In measuring the resolving power of a telescope system the ocular should be withdrawn slightly to form a real image just in rear of the telescope ocular. This image may then be examined by an independent ocular. Objectives are examined by a single ocular of short focal length, (that is, high power), which with the objective forms a telescope system.

Astigmatism

Pencils of rays lying in two planes at right angles to each other are not refracted by a lens to a single focal point, even though the correction for spherical and comatic aberrations are perfect. The two aberration corrections are for a single plane. The error due to the variation in refraction of light in planes at right angles to each other is known as astigmatism. Ordinarily astigmatism in lenses is produced by means of cylindrical surfaces (instead of spherical) but it is inherent in lenses of true spherical surfaces. It cannot be eliminated in the ordinary form of lens. In lens systems properly corrected for spherical and comatic aberrations, the residual astigmatism, however, does not interfere with vision.

Astigmatism is often noted in telescopes, being recognized by the necessity of refocusing for removal of parallax from horizontal or from vertical wires. Sometimes refocusing may be required on account of the distance between reticule lines. Ordinarily it is due to astigmatism. Astigmatism may also be present in a prism system. The various elements must be tested separately to locate the cause of the defect.

The quantity of astigmatism present in a lens may be measured by determining the difference in the position of the image planes for vertical and for horizontal lines of a distant object. Qualitatively it may be recognized, especially in reduced light, by a test piece ruled with lines radiating from a common center, similar to the test piece used by opticians for detecting astigmatism in the eye.

Astigmatism is a common defect in prisms and other flat work. It is usually due to the grinding of cylindrical instead of plane surfaces. Its presence in prisms may be detected by permitting light to pass through it in the same path as normally used and examining the emergent pencil with a telescope. The defective surface may be readily detected by means of a color test glass.

Curvature of the Field

The image formed by a telescope objective does not lie in a plane but, if stigmatic, in a section of a spherical surface whose radius depends primarily upon the radii of curvature and the refractive indices of the elements of the system. Fig. 6 indicates the formation of the image for rays from various parts of the field. The radius of curvature of the field may be increased by the selection of a crown glass whose refractive index is greater than that of the flint glass. This is possible by use of the newer types of glass. In a telescope the angular field of view is so small that ordinarily no difficulty is experienced from the curvature of the field formed by a well designed objective. In instruments of large angular aperture, the reduction of curvature of the field becomes of greater importance.

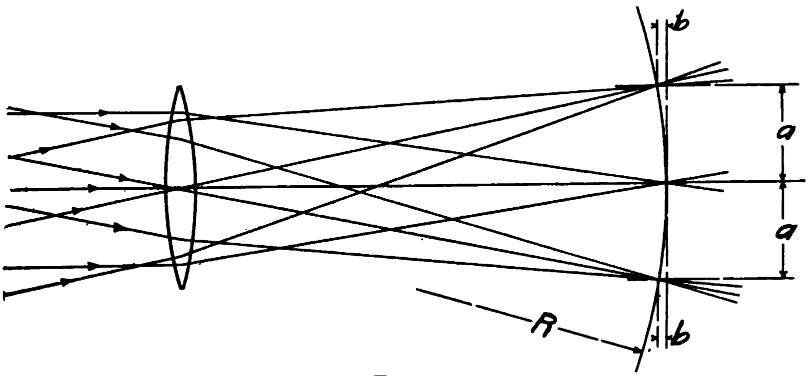


Fig. 6.

The radius of curvature of the image of an object may be determined as follows. Focus a high power ocular at the axis of the image formed by an objective and remove parallax from the reticule. Then move the eye piece a given distance in a plane normal to the axis of the telescope, refocus and remove parallax frcm the reticule. Repeat the test at the same distance on the opposite side of the optical axis. If a is the distance the eye piece is displaced perpendicular to the optical axis of the system and b is the distance parallel to optical axis the reticule after adjustment for the center of the field is moved for removal of parallax at the distance a from the center of the field, the radius R of curvature of the field is

$$R = \frac{a^2}{2b}$$

Distortion

Distortion is due to the difference in magnification in the outer zones of the field. The center is little affected. If an object consisting of parallel sets of lines perpendicular to each other is observed, the image may appear either cushion shaped, or barrel shaped, depending upon the character of distortion present (see Fig. 7).

The amount and character of distortion may be varied by change in the location of stops. For some work freedom from distortion is essential. The distortion present in a high grade telescope is not sufficient to be noticeable. No particular difficulty is experienced with this defect in the designing of telescope objectives. It is ordinarily more troublesome in some classes of oculars and in magnifying glasses.

The presence and character of distortion in an optical system may be determined qualitatively as suggested above. In the inspection of ordinary telescopes its quantitative determination is not necessary. In well designed telescopes little or no distortion should be apparent.

Fig. 7.

Minor Defects

In addition to the defects classified above, for which the mathematic theory has been developed, there are certain other defects of design which may condemn an optical system. An objective calculated for freedom from chromatic and spherical aberrations and coma, although free from those defects, may yet fail in a practical test, especially from flare. At each surface some light is reflected as well as refracted. The refracted light forms the desired image. It may be that the relation of the curvatures of the surfaces of the lenses is such that some of the reflected light is after two or more reflections refracted into the eye in sufficient quantity to cause a misty or hazy appearance of the image. If this flare appears, it is necessary to

redesign completely the objective. This is entirely a matter of trial—no formulae are known for predicting the appearance of flare. If developed they would be extremely tedious to use.

During manufacture each lens is optically centered and then ground to size making its mechanical and optical axes coincide. In centering, the lens is mounted on a rotating spindle and adjusted until the images formed by reflection from both surfaces of the lens remain stationary while the lens is rotated. The periphery of the lens is then ground. If a lens is not properly centered and the cell containing it is rotated, the optical axis of the instrument will be disturbed. This optical axis is known as the line of collimation. Ordinarily the errors of centering lens cells are greater than errors in lenses themselves. Little difficulty is ordinarily experienced in centering.

Double images, especially of well defined small objects, is often due to incomplete or improper polishing of lenses. In a prism telescope this defect may be due to inaccuracy of angles to which the surfaces of prisms are ground. Thus if double images are observed, the lens system and the prism systems must be tested separately. Some surface of a lens may not be a single spherical surface but may consist of two or more surfaces with different axes. In such a case an image formed by each surface of any considerable area would be apparent. Defects in lenses due to incomplete or improper polishing are liable to occur on account of the duration and the delicacy of the operation. They, however, may be detected by the color test and should be found before the lens leaves the manufacturer.

Limitations of Design

All optical systems contain defects. The character and the amount of defects depend upon both design and workmanship. Practice in design varies between wide limits according to the use to which the instrument is to be put. Defects which may be overlooked in one optical system must be removed at all costs in another. In telescopes, compactness, extent of field, brilliancy of illumination of field, power, the best definition, and freedom from minor defects cannot all be attained. In some lenses the necessity of cementing its various elements precludes the complete removal of primary defects. Again the physical and optical qualities of glass which vary within comparatively narrow boundaries, limit the perfection of optical systems.

The perfection of an optical system depends to a large extent upon the optician's judgment in selecting optical glass. Many types have been developed. In some the optical properties are such as to minimize certain defects, often at the expense of others. Transparency, optical qualities and physical characteristics vary greatly. Some types are comparatively chemically unstable and can be used only in protected places. The condition for achromatism without too great curvature of surfaces of lenses limits the selection of glass of chemical stability rather closely. If the interior surfaces must be cemented (usual in lenses of less than 3-inch aperture) and the aberrations are properly corrected, only a few types of glass are available. In any case, preliminary calculations must needs be made to determine which types of glass are most suitable.

For prism work, glass of extraordinary transparency and of a high chemical stability is available. Little choice in selection is required as defects in prisms are ordinarily caused by poor workmanship. Here transparency, physical homogeneity, chemical stability and in some cases freedom from bubbles are the desirable qualities. A high degree of transparency is especially desirable in the more complex telescope systems. The boro silicate crown prism glass admirably fulfills these conditions.

For ordinary telescope lenses which are exposed to the action of the elements, types of glass with great resistance to deterioration by weathering and by acids present in perspiration are necessary. This qualification at once eliminates the use of the denser flints, the baryta crowns and other types of glass with desirable optical qualities. The best glasses for these results are the boro silicate crown (prism glass), the silicate crowns and the ordinary flints.

TRANSPARENCY

There is a considerable difference in the transparency of various grades of optical glass. Even glass of the same kind varies especially in case of similar glasses produced by different manufacturers. Ordinarily the length of the path of light through a lens system is so small that the differences in the absorption of light by the various types of glass available is of little moment. In prism systems, however, the length of path is usually much greater and the selection of glass with low powers of absorption for the visible spectrum is of great importance.

Light is lost in passing through optical parts from two causes: From reflection of a portion of the energy at each refracting surface and from absorption in the glass medium. The proportional amount of light lost by reflection at each refractive surface is $\left(\frac{\mu - 1}{\mu + 1}\right)^2$. For ordinary glass the loss of light at each surface by reflection amounts to about 4%. The loss of light by absorption varies with the thickness. In lenses the loss by absorption is ordinarily of little moment. In large prisms it may exceed the loss by reflection.

Tests of Objectives

The methods of making test especially for measuring errors arising in the design of objectives have been briefly described above.

The preliminary tests of an objective should include an examination of the optical glass used for freedom from internal strain, determined by polariscope test, comparative freedom from bubbles, liability to spotting, and transparency.

Internal strains in glass result in different indices of refraction for adjacent layers of glass. An example of strained glass is ordinary window glass,—striae or cords and knots are readily visible in this glass. The distortion of objects seen through ordinary glass due to the optical and chemical heterogeneity of the material is a common phenomenon. It is clear that for use in optical instruments even small variations in the refractive index cannot be tolerated. Although the greatest care is required to produce glass free from strains, there is little difficulty in procuring optically and chemically homogeneous glass. None is manufactured in this country, however. The presence of strains may be detected by inserting a piece of glass with opposite surfaces polished in the path of monochromatic light between the pair of crossed nicol prisms of a polariscope. Examined in this manner glass free from strains appears uniformly transparent. If strains are present dark patches or narrow bands of greater or lesser extent appear. In the poorer grades of optical glass striae may be visible even to the naked eye. Such glass is unfit for use in a good instrument.

Some of the best types of optical glass contain numerous bubbles. Glasses absolutely free from bubbles need not be expected. A moderate number of bubbles of moderate size—say about the size of a pin head or slightly larger—are not objectionable. There is ordinarily more objection to bubbles from

their appearance than from any optical defect. The principal optical objection to them is the reduction of light. As this is in proportion of the area of the bubbles to the area of the objective, it is apparent that they are of little moment. If a lens or plate is to be used where a positive image is formed, as for a reticule, glass entirely free from bubbles should be used. In this case the bubbles are magnified by the subsequent optical system and cut off a part of the field.

The accuracy and regularity of surfaces may be tested optically by means of a color test piece. This test piece consists of a piece of plate glass with one surface accurately ground and polished to the required radius of curvature and the other ground and polished plane. For testing, the work and test piece are carefully wiped off and particles of dust and lint removed by a camels hair brush. The test piece is then carefully slipped over the work and held so that light from a well illumined source will be reflected into the eye. Part of the incident light will be refracted into the test piece and reflected at the second surface back through the test piece and into the eye. A part, however, will be refracted from the test piece into the air film between test piece and lens and then reflected at the second surface of the film back through the film and test piece to the eye. The two sets of waves interfere producing what is known as Newton's rings. The difference in the thickness of the air film for adjacent rings of similar color is $\frac{\lambda}{2 \cos r}$ in which λ is the wave length (say $\frac{1}{50000}$ inch for light of medium wave length) and λ is the angle of reflection at the second surface of the film. It will be noted that this is an exceedingly delicate method of measurement. For white light the rings are colored; for monochromatic light they are alternately light and dark. For high class work the rings will be few in number and very broad.

Polishing is a long operation consuming up to eight hours, or even more, for some classes of work. The tendency is to slight the operation. If slighted, the best results cannot be expected. A magnifying glass is used in examining surfaces for degree of polish. The color test is the best indication of the accuracy of polish. On account of the cost of color test pieces, they are only used when a number of lenses of the same curvature are to be made.

The definition of a telescopic system depends primarily upon its freedom from primary, chromatic, spherical and comatic aberrations. It is independent of magnifying power or field

of view, and should be clearly distinguished from them. It should also be differentiated from the angle of resolution which is dependent upon magnification. In a sense, definition depends upon the summation of all the various defects of design and of workmanship. The term "definition" is relative, based upon the comparison of one telescope with another. However, it is preferable that the telescope systems contrasted for definition be of equal magnification, otherwise it will be difficult to compare the fineness and sharpness with which minute details of an object are brought out in various parts of the fields of the two instruments. If the definition is the best, the normal eye should feel free from all muscular strains of accommodation and should experience that sense of pleasure arising from perfect vision without discomfort or effort of any kind.

In all tests of telescope objectives care should be taken that the light refracted by the objective for the required field of view is not cut off by stops. In the cheaper work the aberrations are reduced by stops or diaphragms. This results in reduction of the intensity of illumination of the image. An image of the objective of a telescope, known as the eye ring, is formed in rear of the eye piece. It is readily recognized by moving a piece of transparent paper in the path of the light back of the eye piece until the light spot apparent has a sharply defined edge. If a pencil point or other object be moved across the face of the objective the image of that object will be plainly visible on the eye ring. If the pencil, while resting on a portion of the objective is not visible in the eye ring, then light from that portion of the objective is cut off by internal stops. By this test the effective or clear aperture of a telescope objective may be determined. Any diameter of objective in excess of the clear aperture is pure waste of glass.

All telescope systems have stops which cut off extraneous light but which do not reduce the clear aperture. The field of view is limited thereby. The intensity of illumination of the outer zones of the field is also limited by them but under no condition should the intensity of illumination of the central portion of the field be reduced.

It will be noted that no tests for intensity of illumination are made, nor are they considered necessary. This factor depends primarily upon the design of the optical system and upon the transparency of the glass used. A knowledge of these elements is of more value than any photometric tests made. In experimental work as an aid in designing, photometrical investiga-

tions of optical systems are of great value. Of course for night work a maximum intensity of illumination is necessary. The attainment of the proper intensity is a problem for the designer. If the design is good and the optical elements give excellent definition, no difficulty will be experienced from lack of intensity. Some of the tests for intensity are misleading as they divert attention from what is of the highest importance in optical systems.

PRISMS

Defects in prisms are ordinarily due to errors in the grinding of faces to the proper angles and to imperfect workmanship in polishing the faces. Borosilicate crown prism glass is ordinarily used. Plate glass or inferior optical glass is not acceptable for good work. Plate glass may be recognized by its green color. Borosilicate crown glass is practically colorless.

The tests of glass for prisms to determine its physical, chemical, and optical properties are the same as described above for objectives.

The accuracy required in the grinding of prisms varies greatly according to the use to which they are to be put. In the case of Brashear-Hastings erecting prisms the roof angle between the two upper polished surfaces must be accurate within small limits, say not over 20 seconds of arc; while in the case of the prisms used in the porro erecting systems, errors amounting to 5 minutes of arc may be tolerated. The allowance error differs with different types of telescopes and the methods used in adjusting the prism in its seat. The error of angles of prisms is measured by a spectrometer. The accuracy of workmanship may be judged qualitatively by various practical tests.

If a right angled triangular prism is held with its face of greatest extent toward the eye, the image of the eye will be formed by reflection on the other two faces. The image of the pupil of the eye formed in this manner will appear round if the error of the right angle is very small, or oval if the error of the angle is appreciable. For a more sensitive test a telescope may be used, in which case the image of the objective or of the objective cell will be examined for distortion. Ordinary errors in porro prisms do not interfere with the definition of telescopes.

In telescopes in which the reversal of the image is effected by a single prism, as in the Brashear-Hastings prism, errors in the angle between the two faces by which reversal is accom-

plished, cause double images of vertical lines. If the eye is held at the center of the eye ring of a telescope with a defective prism of this type two equally bright images of a line near the center of the field will be observed; if the eye is moved to the right the right of the two faint lines becomes prominent and and the other is lost to view. Similarly, if the eye is moved to the left the left line becomes prominent. Such defects are confusing and cause imperfect definition. The cost of grinding this type of prism to the required accuracy has resulted in the use of other types of prism systems whenever practicable. In testing telescopes, double images caused by an imperfect objective and those caused by imperfect prisms should be differentiated. To localize the fault it is necessary o test separately each element.

The surfaces of prisms should be plane within narrow limits. If polished with a slight cylindrical surface astigmatism in the telescope system results; if polished with a spherical surface, the prism is given a lens effect. Cylindrical surfaces are by far the more frequent and the more objectionable. There is small chance of obtaining spherical surfaces.

The accuracy of flat surfaces is determined by the color test. In this case the color test piece is a flat plate of glass, with one surface accurately ground and polished and the other surface polished. The test piece is used similarly to that described above for spherical work. The phenomenon is also the same. The direction of the interference bands indicates the direction of the axis of curvature while the width of them indicates the variation of the surface from a true plane.

On prisms with faces about two inches square the errors in the surface should not exceed about two wave lengths. For better work the error will be much less, say not more than one-half wave length. For test glasses or for flat work for experimental purposes the error should be less. Similarly for smaller prisms more accurate surfaces are easily ground.

The fineness of polish of a prism is determined by examination of the surface by a magnifying glass.

Thus for prism work the important points are: The selection of glass of high transparency, optically homogeneous and chemically stable, the grinding of angles to allowable tolerances, the polishing of surfaces to a color test and to a proper degree of fineness. The difficulties in prism design and manufacture are much fewer than in the case of lens work. Here there is little excuse for poor workmanship. A high quality may be

demanded without great increase in cost. Specifications requiring exceedingly close work in the grinding of angles of ordinary prisms, however, will increase the cost.

On account of the extra cost of working to close tolerances in grinding, prisms are seldom made interchangeable, or even reversible. For this reason prisms are marked before disassembling from a prism seat in order that they may be reassembled in exactly the same position. In some cases eccentric slots are cut in prisms and pins inserted in prism holders to prevent assembling wrongly. This is not always done, however, and caution should always be taken to mark prisms before removal from their seats. This precaution applies especially to binocular instruments.

A case comes to mind in which the Porro prisms of one telescope of a high grade field glass were interchanged. The prisms were not ground interchangeable. Consequently the parallelism of the axis of the two telescope systems was disturbed. To compensate for this error squinting was required.

In monocular instruments with the Porro type of prisms, reversal or interchange of prisms may disturb the line of collimation. Ordinarily definition of telescope will not be affected thereby.

On account of the loss of light by absorption in prisms and of the high cost of prisms of large size, it is important that the design of optical system be such that the length of the path of light through a prism system is the minimum consistent with the desired optical qualities. In some cases this may be accomplished by the use of two or more telescope systems in a single instrument. In some of the later models of gun sights the total loss of light by absorption and reflection in the optical system has been decreased by using a more complex lens system and by decreasing the size of prisms. It follows that for maximum intensity of illumination of the field in telescopes of ordinary design in which the aperture of the objective is greater than the aperture of the reticule, the prism system should be inserted as near the reticule as practicable. The intensity of illumination for the center of the field may also be increased at the expense of the illumination of the outer zones by reducing the aperture of the prisms so that say not less than about fifty per cent. of the light incident on the objective from the extreme zone of the field of view passes the diaphragms of the prism seat.

Deterioration

Deterioration of optical instruments is due to both physical and chemical causes. Some agencies as dust and moisture cause both physical and chemical deterioration.

Glass is ordinarily considered to be a stable compound unaffected by water or by chemical agencies except a few acids. This impression is far from the truth. Some optical glass is hydroscopic and can be little used. Some types of glass are easily spotted, the touch of the finger being sufficient to spot a polished surface. Such unstable glasses are used only in protected places. But even the more stable glasses used in service telescopes are subject to chemical decomposition.

Physical Deterioration

The most common and one of the most harmful agencies affecting optical glass is dust. Its action is both chemical and physical. The bodily pressure of dust particles cuts off much light that otherwise would pass through an optical system, thereby reducing the intensity of illumination. In some cases telescopes have been examined in which good definition had been destroyed by the accumulation of dirt upon the glass surfaces. Even though dust caused no other reactions, its effects upon the optical qualities of a system are sufficient to warrant extreme care in the protection of optical parts. But that cleanliness of optical surfaces is a necessity appears to be one of those self evident propositions that one never heeds. Probably few realize the almost universal neglect of this first principle.

It will be apparent that if an objective or prism is covered with dust, the effective aperture of that piece is reduced by the ratio of the area of the surface covered with dust to the whole surface. In the presence of moisture the accumulation grows more rapidly and becomes more harmful. It is often possible to convert poor definition into good simply by cleaning.

If the temperature of glass is lower than the dew point of the surrounding air, deposition of moisture occurs. This film of water is destructive of good definition. Although temporary in character, it may render a telescope useless until removed. The condensation on optical surfaces is especially liable to occur on telescopes used at the seacoast. Deposits on exposed optical surfaces although harmful are readily removed. On interior optical surfaces they are the most troublesome. The difficulties due to the condensation of moisture may be lessened by

the storage of telescopes in dry places when practicable, and by preventing the circulation of air into the interior portion of telescopes. Although clearances between metallic parts of a telescope are small, yet condensation may not be wholly prevented. It sometimes happens that films of moisture are deposited between the two elements of an objective which is enclosed by the ordinary form of cell. Some relief from interior deposits of moisture may be obtained by turning on the electric lights used for illumination of reticules, when possible, a few minutes prior to the time of use.

One of the most harmful and the least excusable causes of physical deterioration of lenses is scratching. Optical surfaces are readily abraded even by objects of lesser hardness. The cause of most scratches may be traced to carelessness or ignorance in handling. The greatest care is required during manufacture in grading and keeping separate the various grades of emery used in grinding and in keeping abrasive materials from the polishing materials. Optical elements should never be handled except by those with a delicate sense of touch and an appreciation of the difference between a polished glass surface and a metallic surface. It follows that lenses and prisms should not be removed from their cells and holders oftener than necessary.

In cleaning, care should be taken to use only soft clean cloths or papers. Waste, etc., will cause scratches. If a solvent is required alcohol, or ether, may be used. Do not use water—it enters into chemical composition in the surface layers. It is permissible to breathe upon the surface. Do not spit upon the surface, or use anything that may contain a trace of acid or alkali. If dust alone accumulates upon a surface, a camel's hair brush is excellent for cleaning. Be careful not to touch a polished glass surface with the finger—the skin excretions contain acids which are deleterious.

The most difficult part of a telescope to clean is the reticule which lies in the focal plane of the eye piece. Small particles on it are magnified and obscure portions of the field. When cleaning a reticule use a camel's hair brush to wipe the surface and examine the thoroughness of cleaning using the eye piece as a magnifying glass.

Exposed optical surfaces should be given frequent attention. In well designed instruments, interior surfaces require attention only at long intervals. Some instruments are designed for the cleaning of interior optical parts only by the manufac-

turers. It is indeed a question as to whether optical parts suffer deterioration more from lack of cleaning, or by lack of skill and knowledge in cleaning. (This statement does not apply to exposed surfaces or to surfaces to which dust has access.)

In the care of instruments precautions should be taken to prevent oil reaching any optical parts of instruments. Many telescopes have been examined in which optical elements were covered by a film of oil. In some cases the acids contained in the oil had eaten into the glass. It would probably surprise many who clean telescopes to know how much surface a drop of oil will cover. Only telescopes with interior rotating parts require interior oiling, as for example, a periscope or panoramic sight. A drop or two of oil is sufficient.

Where telescopes are disassembled for cleaning, care is required to mark all lenses to show the direction of light in passing through the system. As explained above, the direction of light is considered in designing objectives and eye pieces. Assembling in any but the correct manner will cause an increase in the aberrations and in some cases produce visible distortion. The reason for care in assembling prisms has been explained above.

Glass is an exceeding brittle substance of low tenacity. Cells and holders are made with clearance between the metal and glass to allow for unequal expansion. In inserting an objective in its cell the objective may become wedged and if too great pressure is applied will be fractured. The dispersion element of an objective, on account of its thinness at the center, is liable to be broken during cleaning. The lens shown in Fig. 8 was probably broken in this way. Similarly the edges of prisms are easily chipped. Objectives especially are easily splintered or fractured by the dropping of a telescope.

Many lenses and prisms are built up of two or more pieces cemented by balsam. The balsam deteriorates with age, or may be broken by shock. This deterioration may be readily recognized especially in reflected light. Fig. 9 shows the breaking away of the cement probably due to shock. The imagery of broken cement may consist of small patches, sometimes of regular outline, sometimes of fantastical shapes, or it may be extended widely over whole surfaces. The color of the broken cement is whitish, or yellowish. The effect on the optical system is similar to that of most other defects, diminution of light and destruction of definition. The recementing of lenses and prisms is entrusted only to experienced workmen.

FIG. 8.

Fig. 9.

Fig. 10.

FIG. 11.

The quality of balsam available for optical work varies greatly. Good balsam is of a light straw shade, not yellow,—almost colorless and filtered. The deep straw and amber shades indicate the presence of resins. Only the best filtered balsam is used in high grade optical work.

Any play of prisms in their seats causes changes in the line of collimation of telescopes. In some designs of prism holders this looseness may increase under shock causing large errors.

Some types of prisms are held in their holders by means of plaster of paris. The plaster deteriorates with age and requires examination about once a year. If it shows signs of crumbling or deterioration, replace it by the best grade of dental plaster, which sets in about ten minutes. Before replacement carefully readjust the prism. In all work of this nature extreme caution is required not to introduce strains in the glass. Screws bearing directly or indirectly against an optical surface are brought to contact but not in the least strained. Mechanical stresses in glass cause variations in the optical properties.

Chemical Deterioration

Dust particles, especially on flint and baryta glasses become the center of surface decomposition and the formation of dark or brown patches known as lead spots. The rapidity of formation of these spots depends upon the chemical composition of the glass,—those glasses with high percentage of lead being more susceptible. The ordinary flints are comparatively stable. These lead spots are irregular in outline and gradually spread until large patches of surfaces are affected. They cannot be removed by wiping or ordinary rubbing but must be polished out by an optician. They occur on both exterior and interior surfaces. Fig. 10 shows the formation of lead spots on the flint of an objective which had been in service about six years. Fig. 8 shows a formation in a flint which had been in service in a tropical climate probably not over two years.

The pressure of barytas in glass apparently promotes the dusty disintegration. Fig. 11 shows the formation of spots on a baryta crown glass which had been in service probably about two years. It belongs to the same objective as the flint in Fig. 8. One spot is irridescent. It will be noted that the brown spots are in the form of long narrow patches near the periphery of the lens.

Hovestadt states that from tests made at Jena silicates without lead are also subject to dusty disintegration, the rapid-

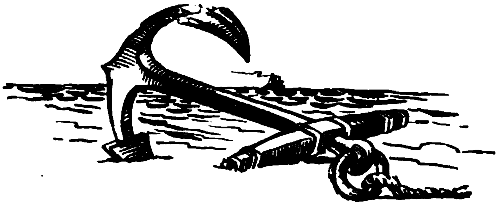
ity of disintegration depending upon the amount of alkali present. Little trouble has thus far been experienced with silicate crowns or borosilicate crowns ordinarily used in service telescopes.

To examine a glass surface for corrosion, hold the piece so that light is reflected into the eye. These spots will not be visible in refracted light. Use the lens surface as a mirror and focus the eye on the lens surface. All lens defects are examined thus.

The phenomenon known as lead spotting is, according to Dr. E. Zschimmer of Jena, due to the action of weak organic acids. According to the same authority lead spotting may be produced by the action of sweat which corresponds to a 0.5 per cent. acetic acid solution. From trial it is known that a weak acetic acid solution causes surface decomposition of glass. Baryta crowns appear especially sensitive to decomposition by this means.

All glasses are soluble to some extent in water. Ordinarily water is taken up into chemical composition in the surface layers and the alkaline contents of the glass set free. Under the influence of carbonic acid in the air, the carbonates of sodium and potassium are formed which are deposited on the surface of the glass in the form of crystals, or dissolved in drops of water on the surface of the glass. In the advanced stages the formation of carbonate crystals on glass may be compared with the formation of ice crystals on a window pane. The rapidity of action varies largely with the amount of alkali present. The action of moisture on flints apparently depends not upon the amount of lead present, but upon the proportion of alkali. Borosilicates have high resisting power although their alkaline content is large.

The decomposition of glass surfaces by weathering is due to both the action of moisture and the action of weak organic acids present with dust particles or elsewhere. The rapidity of action increases with temperature. Thus the action takes place more rapidly in the warm moist climate of the tropics.



PROFESSIONAL NOTES

COMMERCE AND COAST FORTRESSES IN WAR TIME*

A lecture delivered to the Naval and Military Garrison in the Cape Peninsula

By Lieutenant-Colonel W. R. W. JAMES, R. G. A.

(Concluded)

II.

WILL THE CONCENTRATION OF OUR FLEET FOR THE PURPOSE OF CRUSHING OR BLOCKADING THE ENEMY'S AFFORD ALL THE PROTECTION NECESSARY TO OUR MERCANTILE MARINE?

The best answer to this question is an examination of British dispositions during the Revolutionary War. It is admitted that never was our sea power more assured than during that period. Mahan tells us that, after the British fleets had established a preponderance over the masses of the enemy, the latter was reduced to commerce destroying.

> "To these raids upon their shipping by numerous scattered cruisers the British opposed a two-fold system. The convoy system, the essence of which was to concentrate the exposed wealth of the country under the protection of a force adequate to meet and drive away any probable enemy."

He then tells us that, in order to guard those who were unwilling to incur the delays inseparable from the gathering together of vast numbers of ships, and also those which had the misfortune to be separated from their escort.

> "Fast frigates and sloops of war with a host of smaller vessels, were disseminated over the ocean upon the tracks which commerce follows, and to which the hostile cruisers were therefore constrained.
>
> "The forces, thus especially assigned to patrol duty, were casually increased by the large number of ships going backwards and forwards between England and their respective stations, despatch boats, vessels going in for repairs or returning from them, so that the seas about Europe were alive with British cruisers. To these again were added the many privateers, whose cruising ground was not indeed assigned by the Government, but which were constrained in their choices by the same conditions that dictated at once the course of the traders and the lair of the commerce destroyer."

In spite of these dispositions our losses were so great, that an Act, known as the Convoy Act, was passed in 1798, compelling the taking of convoys.

* Continued from *Journal U. S. Artillery*, September-October, 1911.

It should be noticed that this Act was passed three years after "the French formally abandoned the policy of keeping great fleets together and took to the *guerre-de-course*."

It will thus be seen that even against commerce destroyers acting singly careful measures of protection and the employment of large forces was essential.

Where such protection has not been provided the consequences have been disastrous. Speaking of the commencement of 1793 Mahan remarks:—

> "At the outbreak of the war, Great Britain was taken unawares in India as everywhere: From September, 1793, till October, 1794, a single sloop of war was left to protect the vast expanse of ocean covered by the East Indian Company. Under these circumstances the losses were inevitably severe, and would yet have yet been more heavy had not the Company itself fitted out several ships for the protection of trade. An animated warfare directed solely towards the destruction and protection of commerce now ensued for several years."

Mahan then mentions how in 1805 Mr. Edward Pellew by his skilful arrangements afforded such security to trade that premiums fell to 8 per cent., with a return of 3 per cent. if sailing with convoy.

> "But during the very period that these happy results were obtained by wisely applying the principle of concentration of effort to the protection of commerce, disaster was overtaking the trade of Calcutta, which lost 19 ships in two months through the neglect of its merchants to accept the convoys of the Admiral."

OPERATIONS OF SUFFREN AND RODGERS

Losses were, however, even more severe in cases when attacks on trade were more systematically carried out. Suffren's campaign in Indian waters in 1782 is a good instance of this. In order to avoid having to take his ships to his distant base at Mauritius he equipped and re-victualled his squadron by preying on his enemy's commerce, with the result that insurance premiums went up to 15 guineas per cent., and this at a time when the rival fleets were not very unequal in strength.

The operations of the American squadron under Commodore Rodgers in 1812 are of very great interest, showing how much can be effected by the weaker belligerent, both in attacking his enemy's commerce and defending his own, by adopting a bold line of action; and, I think, offer a strong argument in support of the necessity of our being prepared to find our antagonist, in a future war, operating with a fighting squadron in centers remote from Home waters immediately on the outbreak of hostilities.

Rodgers with 3 frigates and 2 smaller ships started out in search of a West Indian convoy which he knew had sailed from Jamaica, and missing it, "continued his chase to within 20 hours of the English Channel."

The results of his action were that he forced the English cruisers to concentrate to avoid the risk of being surprised and beaten in detail by an enemy of whose whereabouts they had no knowledge; thus preventing them from intercepting the American trade or effectually watching their ports.

SPECIAL PROTECTION FOR COMMERCE INDISPENSABLE

I think we may fairly conclude that special precautions are necessary to protect commerce in war time and that these precautions must involve the employment of large numbers of cruisers.

The nation with the largest mercantile marine will be most vulnerable, and need a proportionately larger number of cruisers for this purpose.

Let us compare this opinion, deduced from historical facts, with that expressed by the First Lord of the Admiralty in his speech in the House of Commons, March 16th, 1909.

(*National Review*, November, 1910, p. 405.)

> "There is no nation in the world which has anything like the same dependence on foreign trade that we have. Its loss to us would be a vital blow; to any other nation it would be merely an inconvenience.
>
> "Our commerce, if unprotected in remote seas, would be open to attack by foreign armed merchant vessels, especially commissioned for the purpose as ships of war. Victory at sea in Home waters would not necessarily protect our foreign trade, nor would it necessarily bring the war to a close. On the other hand defeat in Home waters would certainly end the war, and would be the surest means of protecting the antagonist's foreign trade. I make these observations merely by way of a brief explanation of our special need of cruisers, and to show that calculations of battle strength in which they are all reckoned as available in Home waters, are based on an incomplete appreciation of their true functions."

III.

Are We in a Position to Secure so Absolute a Maritime Preponderance on all Our Trade Routes as to Frustrate any Attempts on Our Commerce?

This appears a question to which a definite answer is very necessary.

In reply to suggestions that an enemy might detail commerce destroyers to operate against our trade centers abroad, one is generally told that any vessel so despatched would be immediately followed and dealt with by a superior force.

If such is the case surely we should have been even better able to do so in the year 1806.

I think the following quotations from Brenton's Naval History may raise some doubts in the minds of disciples of this creed.

> "The battle of St. Domingo, following the splendid victory of Trafalgar seemed to have completed the ruin of the French Navy. The history of nations has few examples of such a series of successes as those obtained by the fleet of Great Britain between the 22nd July, 1805 (Sir R. Calder's fight off Ferrol), and February 6th, 1806. In that time the enemy had lost 34 sail of the line; and their crews which were either destroyed or made prisoners, amounted to 25,000 men. Their merchant fleet had long since been nearly annihilated, their Colonial trade was carried on by neutrals."

He proceeds at some length to explain how in spite of these results we were unable to diminish in any way the expense of our Navy. Napoleon built new ships and

> "by this semblance of a fleet waged a war against our finances and paralyzed a large portion of our Navy. . . . . . and though he had long decided that the attempts to invade England could only end in mortification and disaster to himself, and had relinquished the project, yet he knew that the flotilla, if only kept in view of the coast of England, would answer all the purposes of intimidation to one part of the nation, and of expense to the whole. In fact, Boulogne was watched, during many years, with a British force far exceeding the importance of the object; at the same time the best ships of the enemy were employed in cruising in small squadrons, to our considerable annoyance."

It would be tedious to attempt to catalogue our losses in detail, but it is certainly worth consideration that Rear Admiral Allemande commanding the *Rochefort* squadron, consisting of 5 ships of the line and 3 powerful frigates besides smaller vessels, was able to cruise for 161 days, and captured the *Calcutta* of 54 guns, the sloop of war *Ranger*, and 52 sail of merchant vessels of different nations; for the French of that day were never very scrupulous on the articles of neutrality.

This it must be remembered occurred in home waters. We were not able to deal successfully with the commerce destroyers in either the East and West Indies till 1810.

The whole question seems one of proportion.

IV.

Have We Now More Cruisers in Proportion to Our Mercantile Marine Than We Had in the Beginning of the Last Century?

In 1812 the Royal Navy had at sea

- 120 ships of the line.
- 145 frigates.
- 421 other cruisers (16 larger, the rest smaller than the frigate class).

Napoleon had

- over 100 ships of the line
- and 50 frigates, in various ports from Antwerp to Venice. (*Naval Chronicle, XXVIII.*, page 248.)

The number of any possible opponent's available commerce destroyers must be considered, though this is not such a vital factor, for Mahan, after a very thorough investigation, comes to the conclusion that the convoy system

> "When properly systematized and applied, will have more success as a defensive measure than hunting for individual marauders—a process which, even when most thorougly planned, still resembles looking for a needle in a haystack." (*Influence of Sea Power upon the French Revolution and Empire.* Vol. II., page 217.)

Not only however, must the numbers of cruisers be sufficient, but they must be of sufficient strength and speed to hold their own against hostile commerce destroyers.

We had a very sharp lesson on this point when America declared war in 1812.

A long list can be drawn out of our losses in frigates owing to the superior power of the American cruisers. It must be remembered that the Americans had no line of battleships, and simply embarked on commerce destruction, and we were sustaining these reverses at a time when our sea power was so assured that we could harry American ports and make successful descents upon the coast.

Brenton gives the number of American vessels taken by us during the war as 1400, and adds that our losses were numerically as great, and probably of more intrinsic value. Had we possessed suitable vessels for the defence of commerce at the commencement of the war it would have made a great deal of difference.

In arriving at our estimate of available commerce protectors we must remember that small ships, of nominally high speed, are enormously handicapped. About 25 years ago our naval maneuvers embraced the idea of a war on commerce. The Atlantic liners, when pursued, simply put their heads to the wind and walked away from small war vessels, which nominally possessed a speed greater by several knots. This is a point worth remembering.

It is the large mercantile liners that are subsidised by other nations with a view to using them as commerce destroyers in war time. It is well known that an armed merchant liner is no match for even a small war ship in actual fighting; but, as she can successfully elude a small adversary by superior speed in the open sea, the presence of such vessels along our trade routes will demand the employment of large cruisers to deal with them.

It is open to all to see for themselves in Jane or Brassey the numbers of such cruisers which we should have available after the needs of our main fleets were satisfied.

V.

Can We Afford to Ignore the Injury We May do to Our Enemy by Attacking His Commerce?

In the past to a very great extent the two duties of protection of one's own and destruction of the enemy's commerce could be performed by the same ships. Moreover the chances of making large sums in prize money was a great incentive to enterprise. The loss of her merchant shipping, though a great blow, would not affect any Continental nation in the same manner as it would England.

In the old days when land communications were so bad, France was nearly as dependent on sea communication as we were; and the battle of 1st June, 1794, was fought by the French to cover the passage of their American and West Indian convoy, as the country was reduced to a state bordering on famine. Owing to the facilities offered by railways, any continental country can supply herself with food through neutral ports. By the Declaration of London, food cannot be made conditional contraband if consigned in a neutral ship to a neutral port.

There is no doubt, however, that any action, which tends to drive our enemy's merchant shipping from the sea, or causes it to be transferred to a neutral flag, must exert some pressure, and therefore we may expect to see our own navy resort to commerce destruction as far as it is compatible with other duties.

VI.

How Will a Naval War, Directed Towards Commerce Protection and Destruction, Affect His Majesty's Land Forces?

ATTACKS ON THE ENEMY'S BASES

Mention has already been made of the length of time the commerce destroyers in both East and West Indies survived the downfall of the main French fleets, and it seems certain that it was entirely owing to the fact that in both cases secure bases for the cruisers existed, and that commerce destruction was undertaken systematically, supported by squadrons strong enough to afford effectual resistance to the forces we had at our disposal. Brenton says (Volume II., p. 326),

> "The Islands of France and Bourbon were now all that remained to the French, East of the Cape of Good Hope. The shelter afforded to shipping, and the resources possessed by the first of these Islands for equipment and victualling ships of war and privateers had enabled the enterprising French Officers to do incalculable injury to our Indian commerce. The success of De Sercey, of Linois, of Bergeret, and du Perrie, were in a great measure owing to the facilities with which they made good the defects of their ships at Port Louis. In 1809, when the depredations of our enemies had exceeded all bounds, when our Navy though triumphant could not correct the evil, either by blockades or by bringing their ships to action, the British Government in India considered the subject as worthy of its attention."

It is impossible to give the history of the subsequent operations in detail, but it may be noted that in one attempt on the island we lost four frigates. The French took another frigate in the fighting preceding the final expedition, and also an Indiaman fitted out as a ship of war, on board of which were Major-General Abercromby and his staff. Fortunately, as Abercromby was the General entrusted with the command of the army intended to reduce the Isle of France, they were retaken in a French frigate *La Venus*.

When the final attack was made the fleet was commanded by a Vice-Admiral, and included 1 line of battleship, 12 frigates, and 4 smaller war vessels; the total fleet consisted of 70 sail, so that the number of troops employed must have been considerable. Four French frigates and 3 smaller war ships besides two of those previously taken from us were captured in the harbor.

The fighting in the West Indian Islands, so lightly passed over by Mahan, was on an altogether larger scale. Squadrons of battleships and large bodies of troops were employed. The principal lesson for us is the danger of attempting to hold bases with inadequate bodies of troops.

After Guadeloupe was captured in 1749 it was retaken by the French, and remained a thorn in our side until its ultimate capture in 1810. The French losses on this occasion were 600 killed and wounded and 2,000 prisoners.

ATTEMPTS BY THE ENEMY TO ACQUIRE BASES

It appears, from these instances from history, that if an enemy wishes to harass our trade seriously, he will require a strong base from which to operate. Modern ships are more dependent on bases than were sailing vessels.

It may be objected that our most likely antagonists are not possessed of these desirable adjuncts to commerce destroying. Bases, however, may be acquired in more ways than one. They may be seized from the enemy himself if he neglect to hold them with a sufficient force to guard against surprise or leaves them altogether ungarrisoned. For such a purpose a small island is the most suitable. It is often asserted by responsible people that a lodgment on the mainland for such a purpose is impossible.

Although Gibraltar is not a commercial port, the purpose for which we hold it is immaterial to the question under discussion. When we abandoned the Mediterranean in 1780 Gibraltar defied capture for nearly three years, with practically no support, except for the supplies and reinforcements thrown in by Admiral Derby in April, 1781, more than a year after the commencement of the siege. Yet it was captured easily enough by Rooke in 1794 when it was insufficiently garrisoned. Most of us can call to mind other places in different parts of the world which could be easily held by a sufficient garrison. The port of a weak neutral may be forcibly occupied for the purpose. Neutrailty of nations unable to enforce their rights has constantly been disregarded in naval warfare.

There is a third way. When Napoleon wanted the Dutch ports he simply occupied the country, and under certain contingencies it seems not improbable that this procedure might be copied. Both Holland and Denmark have foreign possessions which might be utilised as bases for commerce destroyers.

In estimating the chances of our commerce being seriously interfered with, we must not overlook the fact that we cannot count on numerical superiority in capital ships against the most probable coalition in the present political condition of Europe.

COMPARISON WITH THE POSITION IN 1778

It is outside the scope of this paper to serve up a rechauffé of the monthly magazines. But I think that it will easily be recognised that, if we should be forced into a war with the triple alliance, with perhaps the forces of Turkey added to theirs, a strategic situation would be produced not very dissimilar to that of the war of 1778-82.

The policy of France before this year had been:

> "To follow the tendencies of British Commerce; to observe in England the state of the troops and armaments, the public credit and Ministry; to meddle adroitly in the affairs of the British Colonies. . . . to develop actively but noiselessly the Navy, . . . to fill our storehouses and to keep on hand the means of rapidly equipping a fleet . . . . finally, at the first serious fear of rupture to assemble numerous troops upon the shores of Brittany and Normandy, and get everything ready for an invasion of England, so as to force her to concentrate her forces, and thus restrict her means of resistance at the extremities of her Empire."

Mahan quotes this from Zapeyrouse-Bonfils, a French naval author. (*Influence of Sea Power*, page 337.)

Another quotation on page 341 of the same work, with every little alteration, might be taken from a current newspaper. This is a statement of

the First Lord of the Admiralty made in the House of Lords in November, 1777, a very few months before the war with France began:—

> "We have now 42 ships of the line in Commission in Great Britain (without counting those on foreign service), 35 of which are completely manned and ready for sea at a moment's warning.
>
> "I do not believe that either France or Spain entertains any hostile disposition towards us; but from what I have now submitted to you, I am authorized to affirm that our Navy is more than a match for that of the whole house of Bourbon."

Mahan adds

> "This pleasing prospect was not realised by Admiral Keppel when appointed to command in the following March, and looking at his fleet with (to use his own apt expression) 'a seaman's eye'; and in June he went to sea with only 20 ships."

England was forced absolutely on the defensive, she could not be strong everywhere, she was driven out of the Mediterranean; the Channel fleet was so inferior that "it was difficult to find an Admiral willing to accept the chief command."

The allied fleets

> "captured an entire convoy, largely laden with military stores for the East and West Indies. The entrance of 60 British prizes, with nearly three thousand prisoners, into Cadiz, was a source of great rejoicing in Spain."

My object in quoting the above is to show that the allies were able to choose their own objective, and attack when they liked. As a matter of fact, their greatest effort was centered on the West Indies, and that choice was largely dictated by commercial considerations. It seems not unlikely that a sufficient force could be spared by our probable antagonists to seize and hold a base in the Atlantic, from which to operate against the food supplies to Great Britain, whilst still maintaining in home waters a fleet sufficiently powerful to prevent our detaching a force to cope with it successfully. What the consequences of the interruption of the food supply for a few weeks would be is not very hard to predict.

EFFECT OF THE DECLARATION OF LONDON

The Declaration of London making food supply a conditional contraband of war supplies an additional incentive to such an attack. As it stands at present all food conveyed to an English port in neutral bottoms is liable to capture. It has often been asserted that America would not tolerate such an attack; but we must remember that a neutral, in spite of very drastic treatment, is generally unwilling to become a belligerent, as the inevitable results of a war is to benefit the trade of all neutrals. Further there is the element of time. Owing to the astonishing rapidity of events under modern conditions of warfare, it is quite conceivable that Great Britain might be brought to the verge of starvation before a neutral nation had decided on its line of action.

It would be equally open to our enemy to direct his expedition against any other of our trade routes, and whether he seized an unfortified port, or

attempted to capture one of our bases, the result would be a call on the British land forces.

EMPLOYMENT OF TROOPS AGAINST FRENCH BASES

The amount of hard fighting that has been put in by the army in similar cases can only be gathered in works like the Diary of Sir John Moore. It must be insisted on that the expeditions to the West Indies in which he took part were entirely in defense of our commerce. Mahan is very clear on this point.

> "During the French Revolution about one-fourth the total amount of British Commerce, both export and import, was done with them.
>
> "The presence of hostile cruisers not only inflicted direct loss, which was measured by their actual captures, but, beyond these, caused a great direct injury by the friction and delays which the sense of insecurity always introduces into commercial transactions.
>
> "The ideal aim of the British Ministry was to banish the enemy's cruisers absolutely from the region; but, if this was impossible, very much might be effected by depriving them of every friendly anchorage to which they could repair to refit or take their prizes, in short, by capturing all the French Islands." (*Influence of Sea Power on the French Revolution and Empire.* Vol. I., page 111.)

Seven ships of the line were sent out March, 1793 with troops and effected nothing. Seven thousand troops were employed in 1794 at the capture of Martinique which occupied six weeks, the same force afterwards taking St. Lucia, Guadeloupe, and other islands; but no less than 16,000 were employed under Sir Ralph Abercromby in 1796.

It is Major-General Sir J. F. Maurice, when editing the Diary of Sir John Moore, who really reveals the part the army played in these expeditions. One extract will bring it home to those who have not previously known of it.

> "The frightful loss of life to the Army involved in these wars must be realised. Bunbury has shown from Parliamentary Returns that, in the two years with which we are now immediately concerned, 40,639 were discharged from the army on account of 'wounds or infirmity,' irrespective of deaths."

NAVAL DETACHMENTS NOT AVAILABLE

Perhaps a word concerning the improbability of naval detachments being available for service on shore in such expeditions may not be out of place.

In the Crimea, Indian Mutiny, and Boer War, and numerous minor expeditions the navy played such a brilliant part, that many are apt to look upon such employment as a matter of course. It must be remembered that in all these instances there was no maritime force opposed to us, nor any great likelihood of any pressing need for their services in the near future.

This would not be the case in a naval war even with an opponent of inferior strength, and it is instructive to read an authoritative pronouncement of the Admiralty to no less a person than Nelson himself. The circumstances were as follows:—

Nelson had landed men to carry on the siege of St. Elmo, and afterwards sent them against Capua. Keith had written ordering him to join the main fleet, July 9th, 1799. Nelson replied refusing, and saying:

> "All our marines and a body of seamen are landed, in order to drive the French scoundrels out of the Kingdom."

This is the Admiralty criticism:

> "Although in operations on the sea coast, it may be expedient to land a part of the seamen of the squadron, to co-operate with and assist the Army, when the situation will admit of their being immediately re-embarked if the squadron should be called away to act elsewhere, or if information of the approach of the enemy's fleet should be received, yet their Lordships by no means approve of the seamen being landed to form part of an army at a distance from the coast, where, if they should have the misfortune to be defeated, they might be prevented from returning to their ships, and the squadron be thereby rendered so defective as to be no longer capable of performing the services required of it; and I have their Lordships' command to signify their directions to your Lordship not to employ the seamen in like manner in the future."
> (*Life of Nelson.* Mahan, Vol. I., p. 451.)

It may be argued that I am straining a point, as the Admiralty letter refers to seamen being sent to a distance from the coast; but Capua is under 20 miles from Naples, and further, the term "distance" is governed by time as well as space. If an attack can be delivered with little or no warning, a very short distance, as regards mileage, may prevent the detachment regaining their ships in time.

CONCLUSIONS

Bases are equally necessary for the protection of commerce. If the convoy system is adopted, harbors are necessary for the purposes of collecting the convoy, as well as for coaling and victualling.

This will inevitably lead to the aggregation of wealth in one place that must prove irresistible to the enemy.

We must give him credit for adopting correct tactics. In such a case he will have an intimate knowledge of the condition of our trade, and will choose a time when it will be most profitable to attack.

He will then embark on a carefully prepared plan, which will have nothing in it of the haphazard raid.

This plan will embrace landing a force of sufficient size to deal with the situation according to his calculations, which will be based on pretty accurate information. As surprise will be a large factor in success, he will not cumber himself with a larger expeditionary force than possible.

Here I think we have all the elements necessary to produce a hard struggle, if the defense is animated by the resolve to hold out to the last; for the assailants, added to the ordinary advantages of the initiative, will be animated by the hope of prize money. It will be too late to remedy matters then, if we have neglected to use the means at our disposal in peace time to heighten the value of every individual by careful training and intelligent study of the ground.

In conclusion I should like to impress on my own branch of the service that it is absolutely indispensable that the garrison gunner should be an all-round man at arms. If our ports are to offer a successful resistance, the Garrison Artillery must understand enough of infantry duties to be able to safeguard their own batteries from a land surprise; not only must they be able to use their rifles in an entrenched position, but they must be prepared to reinforce hard pressed infantry actively on an emergency.

This may seem a large demand, when one considers that their strictly artillery duties must embrace a working knowledge of all descriptions of ordnance: yet it is no more than is required from the bluejackets, and there seems no reason why the training of the land forces should be less complete than theirs.—*Journal of the Royal United Service Institution*, August, 1911.

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THE NAVAL ATTACK OF SEA COAST FORTIFICATIONS

By Captain Berger

Translated from the German by 2nd Lieutenant E. J. W. Ragsdale, Coast Artillery Corps, for the Journal U. S. Artillery.

A battle is of the same importance to land warfare as an engagement between opposing fleets is to a naval war. In time of peace a nation strives to bring its land and naval forces to such a strength and state of efficiency that, as far as man can judge, victory seems assured. Each hopes for success on the land or the high seas. There are many today who strongly maintain that the wars of the future will be decided by a single battle on the land and on the sea. The weaker party will fight to a finish, concentrating in that one grand effort all available money, men, and materials. If this opinion were correct, the vast sums expended yearly for land and coast fortifications should be considered an utter waste of money. This conclusion is obvious, and any war office asking for funds for fortification purposes, under these conditions, would subject itself to severe and justified criticism. The whole theory of a single decisive battle is exploded simply by the fact that appropriations for forts and their equipment are not only asked for, but readily granted. Neither laymen, legislator, nor military authorities raise their voices in protest against the large apportionment of military funds for land and coast defense works.

It has never seemed to me at all probable that an enemy could be brought to terms by a series of victories on land, or sea, or both, as long as his defeated forces still had any fight left in them. In such a case it is more apt to come to a siege of the fortresses, behind which he has retreated; and not until these are reduced can negotiations for peace be seriously considered.

Military operations against land forts have been the subject of numerous writings, whereas the attack of sea coast defenses are but sparsely dealt with. It is partly for this reason that I have chosen the latter for my topic.

As has already been mentioned, sea coast forts may be attacked after a defeated fleet has vacated the high seas and sought shelter behind them. In this case we have assumed that, at the outbreak of war, both naval forces felt confident of victory and that neither tried to avoid an engagement on the open sea. This is, however, only one of three cases. Again, a fleet may be forced to operate against sea coast defenses when the enemy's vessels

refuse to leave their harbor of safety. Thirdly, we have the feint attack. This case may be justified whenever one nation is decidedly the stronger on the seas. Without neglecting the movements of the enemy's fleet, a division or two may be set apart to operate against the coast works. The object of such an attack might be, either, to force the enemy to adopt measures disadvantageous to himself, or to carry the warfare to his own coasts, the question of the supremacy of the seas being merely a matter of time. The manner of attack will, in any case, be suited to the purpose in mind. However, the aggressor cannot afford to run the same risks that he would, were it his object to gain possession of the forts themselves.

History offers numerous examples of each mode of attack, but it will suffice to mention only the following. The Union in the Civil War, having gained the supremacy of the seas, Farragut was sent to operate against the Confederate Coast Defenses. An example of case one is where he forced the mouth of the Mississippi in spite of the fire of Forts Philip and Jackson. Case two is amply represented by the Americans before Santiago de Cuba and the Japanese at Port Arthur. In each case the enemy's fleet had sought refuge behind the fortifications. For case three, we have the example of the attack of Lissa (1866), even if things did turn out contrary to Admiral Passano's expectations.

A careful reconnaissance of the fortifications and surroundings should precede any action on the part of the fleet. I say "should", however, for in most cases of record the attack has always had to be delivered without any further preliminaries.

No one can blame the fleet commanders so much for this omission. The forts, as a rule, are situated high up and such reconnaissance as he can conduct from ship-board is apt to be very meagre and unsatisfactory. He must rely mostly on the information gathered in time of peace, together with what is reported by spies after the opening of hostilities. In very recent years, however, conditions have entirely changed. On the side of the forts, their armament and resisting powers are greatly increased, while the navy has gained a valuable adjunct in the modern flying apparatus. You can now place your fortifications as high as you have a mind to, but the dirigible or air ship will go you one better. The commander on the sea need have his eyes closed no longer as to what the conditions are behind those fortress walls.

But let me state right here at the beginning, that there is a huge difference between seeing and seeing. The observer must be perfectly familiar with coast defense works as well as accustomed to observing from on high. An enthusiastic amateur might bring such information to his chief as would be not only useless, but even fatally misleading. As may be readily seen the matter of the selection and training of observers cannot be lightly dealt with. What is more, in time of hostilities an enemy would undoubtedly attempt to conceal his works. That even the aviator can be successfully fooled, we see from the reports of the late French maneuvers in Picardie. He can, furthermore, expect to be disconcerted by the fire directed against him. Again, a false report in time of war has more significance attached to it than in a mere war game.

It becomes more and more apparent, then, that an admiral about to attack coast fortifications must have numerous, well trained aviators. With these at hand, he can proceed further and decide how best to use them and what he can expect of them.

Today, the gathering of information in time of peace goes on at a livelier pace than ever. One can rest assured that other nations are kept in touch with all changes of another's fortifications. An admiral of a fleet will have at hand an excellent chart of the forts to be attacked, and what is more, it will be more reliable than ever before, as the modern armament has assumed such proportions that batteries cannot be readily moved from one site to another.

A fleet commander desiring to have a reconnaissance of a certain location made, will first assemble all of his airmen and assign to each two of them a portion of the area. They will work individually, however, and check up the details, noting all changes and new works. Cameras will be of great value. The same task is assigned to two as one might meet with an accident. All of the small areas taken together should completely cover the ground occupied by the enemy's scheme of defense.

The observer will first mark out on his chart a line of flight, putting in points from which photographs are to be taken. He will make a sucinct account afterwards of all important features not brought out by the pictures. In order to avoid confusion, both the pilot and observer must work in perfect harmony with each other. The danger of being "winged" by the enemy will necessitate an irregular course with frequent changes of altitude. While this is the best and simplest method of protecting oneself, it does not at the same time, facilitate the problem of reconnaissance,—a fact that indicates more vividly than ever the importance of training in time of peace.

Upon return of the aviators—probably not all present or accounted for—the fleet commander can form for himself a combined picture of the situation, especially in regard to what lies in the harbor and the location of mine fields. If the picture shows loop holes, such will have to be filled in by further reconnoitering. Now, with this completed, he is in a position to go ahead with the disposition of his forces.

The formation eventually adopted will be that best suited to conditions and consequently different for each and every case. Nevertheless, it may be considered a general rule that the attacking fleet will be divided into three distinct divisions. The first division will consist of the different units of the torpedo flotilla, *i.e.*, torpedo boats, submarines, destroyers, and mine boats. To these will be given the work of locating and clearing a channel through the mine fields, of bottling up the enemy's fleet, or of reconnaissance. The submarines should attempt an entrance with a view of destroying some of the ships in the inner harbor. In any case, it is up to the torpedo flotilla to carry on an energetic mosquito warfare. The siege of Port Arthur offers an excellent example of the moral and material effectiveness of such a course

If the fleet succeeds in throwing the shore garrisons into a state of nervous excitement and confusion, it will mean a great step toward ultimate success. The fire from shore will fall off perceptibly in accuracy and effectiveness, thus increasing the chances of the second or battleship division. The action once commenced, it is to this division that we must look for its completion.

The "Old School" has established a rule governing the attack of inland fortifications. It seems, however, to apply just as well to the case of sea coast works. There are ordinarily only two separate cases and, correspondingly, only two modes of attack. The fleet either engages the coast defenses in all earnestness, or makes a feint attack with the sole object of keeping the

enemy busy. In the latter case the sea commander will have more regard for the safety of his ships than for the destruction of the enemy's works. Examples of the first case are the attacks of Lissa by the Italians and Alexandria by the English; of the second, the Americans off Santiago and the Japanese before Port Arthur.

Here, we recognize again the value of a thorough reconnaissance beforehand. The fleet protects itself from all unpleasant surprises which might lead to fatal failures, for, realizing just what fire is to be expected, it can more readily dispose of its forces so as to neutralize most of it.

Just as forts are grouped together in conformity with the contours of the coast, so will the ships (battleships and armored cruisers) be formed in separate and corresponding number of groups. No one group of forts will, then, be left out of the scheme of attack. The attack itself will consist mainly in the bombardment of one specific group of forts.

The questions which naturally arise at this point are: "What formation shall be adopted, which course is to be chosen, what speed, what range, what type of projectile, and what system of fire is to be used?"

For a feint attack the answers are simple enough. The fleet in column formation will steam at top speed over a course parallel to the line of fortifications. It will keep just within its own range limits. All the above is calculated to minimize the danger of the fire from the forts. High explosive shells will be used and the rate of fire will be as high as consistent with the speed and range. Turret guns will fire by salvo, all others singly.

If it is intended, however, to seriously engage the coast works, the above questions must be more thoroughly and carefully considered. We have just spoken of the division of the fleet in as many parts as there are groups of forts. This idea must now be extended to include an assignment of maneuver areas, which is done by drawing from each fortification group radial lines sea-ward. In each sector so formed a battleship or cruiser division will operate against its own objective point. The ships will form for attack in either a loose line (thwart-ships at long intervals), or in a loose column. Either formation determines the course to be taken. In the former case the ships will run directly in and out, while in the latter they will shape an oval course either directly or obliquely to and from the point of attack. All fancy and serpentine courses, etc., with a view to disconcert the range work on shore, are considered today useless. It is far better to steer a straight or consistent course, since the ships' gunners work to better advantage when in perfect understanding with the navigator's ideas.*

The maneuvering area of each division is not only bounded on the sides, but also by the inner and outer limits of range. The latter limit may be synonymous with the greatest effective range, which in turn is determined by the limits of elevation of the guns, the height of the gun platforms above water, the altitude of the fortifications, and the clearness of the atmosphere.

The inner range limit lies at that point from within which, the fire of the ships ceases to be effective, that is, where the shots go over. This happens whenever the object is at, or in front of, the summit of the trajectory. A value for such a range can be readily determined by letting the angle of position ε, be equal to the angle of fall ω, then

* Considering the fact that the range dispersion of fire is about six times as great as the lateral dispersion, it would seem that "loop courses" were more favorable to the ships than the direct frontal attack.

$$\tan \varepsilon = \tan \omega = \frac{h}{r},$$

where h is the height of the target and r the range. However, we cannot afford to leave out of consideration the limit of the elevation of the gun itself E_{max}.

Supposing the striking angle ω' to be zero ,we have

$$\varepsilon = \omega, \text{ and } E_{max} = \varepsilon + \varphi,$$

where φ represents the angle of departure.

It is then obvious that conditions must be such that

$$E_{max} =, \text{ or } >, \varepsilon + \varphi$$

that is, E_{max} must be equal to, or greater than, ε plus φ.

From the above it will be recognized that the inner limit of the maneuver area is dependent on the flatness of the trajectory, which in turn depends on the type and muzzle velocity of each gun. Large guns usually have a flatter trajectory than those of smaller caliber. And so we see that each ship division must work out its own salvation. Charts and tables that have already been drawn up will help the commander materially in solving the problem for his guns and the certain fort group assigned to him for attack.

The determination of course and speed will be made with due regard to fire efficiency. While it would be hardly advisable to suggest actual figures, still let it be said that the smoother the sea, the higher the state of efficiency of the gunners on both sides, the greater should be the speed.

As soon as the range and striking angle permit, the heavier guns will use shot. The inner range limit will be the most favorable position for this type of projectile, since the impact will be nearly normal. At all other times high explosive shell will be used by large and medium caliber guns. Just as in the previous case, turret guns fire by salvo and all other guns individually.

The sole object of the action should be to reduce the fortifications. The probability of success increases proportionately to the lack of equipment, training and discipline on the side of the shore garrisons and to the development of these same factors in the fleet.

To quote Napoleon: "*Un canon sur terre vaut un vaisseau sur mer,*" it would seem well nigh impossible for a fleet alone to withstand the fire of coast artillery.

Now to come to the third line of attack, we have a division consisting of protected and unprotected cruisers. Their mission is to cover the attack from sea-ward on the one hand, and to bombard the inner harbor on the other. With the latter object in view they will keep well out of the range of the forts, but at the same time within the range limits of their own guns and take a course parallel to the coast line. While delivering broadsides from one side, the gun detachments of the other will act as observers. At the end of the course the ships will turn, reversing the roles of the gun crews. In all probability indirect fire will have to be used, but the area will be sufficiently large to warrant it. This has a two-fold object: First, to cause commotion and then, to disabuse the enemy of the belief that he is entirely free from danger thanks to the forts at the harbor entrance. The method of sighting will be to choose an aiming point on the land, the coordinates (vertical and horizontal) of which with respect to the object of fire, are known. All of the rest may be scaled from the chart.

Let us suppose the range to a desired point in the harbor be R, then the corresponding elevation will be E. This latter is set off as sight elevation E_s on the guns. The height of the target is assumed to be the same as that of the gun platform. But seeing that the target is obscured by the intervening coast line we must fall back on an aiming point. This involves an angle of position, which must be subtracted from E to obtain the corrected sight elevation of the piece.

$$E_c = E - \varepsilon.$$

The range tables (indispensable for this work) give for the value of E_c a corresponding corrected sight elevation to be set off on the guns. No change will then have to be made as long as the range remains constant. If at the same time the aiming point is located close to and preferably behind the point of attack, no difficulty will be experienced with the question of deflection.

Should the cruisers take such a course as would involve changes of range, new data will have to be figured out continually. Then again, if the aiming point lies before the target, or well to one side, deflection corrections must be calculated from the chart. Indirect fire in itself offers no difficulties, but it does demand careful preparation before hand and a mutual understanding between gunners and navigators. That high explosive shells will be used goes without saying. The ships will fire broadsides from pre-determined salvo-points. This is necessitated by the system of range finding employed, as elevations and deflections must be figured out for certain points in advance.

The area reached by indirect fire will normally be quite large. Then, when we consider that the effectiveness of shells is independent of the range and that the great distances involve a trajectory high enough to clear the shores, we can surely hope to obtain the object in view. Those within the area will be thrown into confusion and the ships at anchor will be forced to rapidly abandon their harbor of refuge. Here then is work for the torpedo boats, which, up to this point, have been observing the fire from the fleets in conjunction with the air-craft. Each and every movement on the part of the enemy's ships must be immediately reported. If a sortie is attempted, torpedo boats and battleships will engage the out-coming vessels. A naval battle will ensue off the harbor entrance. Naturally, it is incumbent upon the commander of the attacking fleets to see that the action results in his favor.

Furthermore, it may fall to the lot of a fleet to establish blockades and to operate in conjunction with the land forces in a combined attack of coast defenses. Although it is not thought that a well equipped sea coast fort could be taken from the sea alone, still it must be admitted that the naval attack contributes materially toward its ultimate capture. It is for this reason that I have attempted to outline the manner, in which a naval attack might be conducted.—*Artilleristische Monatshefte*, Sept., 1911.

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THE LAND DEFENSE OF COAST BATTERIES AND FORTRESSES

By Major C. G. VEREKER, R. A.

IMPORTANCE OF THE SUBJECT

The rapid growth of foreign naval Powers, and the regrouping of our own fleets to meet present-day conditions, will render it more and more

improbable that, in the initial stages of a war, we shall be able to retain unchallenged command of the sea in all parts of the world.

Until such time as the great naval battles which will eventually decide our fate have been fought, our fortresses and coaling stations, at all events those in distant parts, will have to look after themselves, possibly for much longer periods than was formerly considered probable. Our Navy should be in no way fettered with the responsibility for the safety of ports, but should be confident of finding dockyards, coal and stores available at any time, whenever the strategical requirements of a war may necessitate the presence of our ships.

An enemy, on the other hand, may be more than ever in a position to carry out a successful attack upon some distant station, and such an attack will offer considerable temptation, as, by the destruction of coal stores and repairing facilities, the movements and efficiency of our fleets might be very seriously interfered with. The importance of Coast Defense, is therefore tending to increase at the present time, and some consideration as to the protection from the land side of coast batteries and fortresses may not be out of place.

RESPONSIBILITY OF INFANTRY FOR THE DEFENSE OF LAND FRONTS

This land defense, which is of vital importance, as we shall endeavor to show, should be carefully thought about, and studied, especially by our infantry, who in time of war become mainly responsible for the safety of coast works, and may then have to perform duties in many respects different from what they have become accustomed to, by their training in the field.

> "As a rule infantry will be detailed in defense schemes for the protection of all batteries and electric light emplacements liable to attack by raiding parties, and will supply patrols for the early detection of such raids.
>
> "Gunners are in no way intended to perform the duties of protection, but, if not occupied in fighting their guns, will be expected to assist the infantry in resisting an attack on the rear of the work, except with anti-torpedo boat guns, which may have to be manned at a moments notice."*

INCREASED VULNERABILITY OF COAST DEFENSE ARMAMENT

During the past few years greater importance has been placed upon the adequate protection of batteries than was formerly the case. One reason for this is the very greatly diminished number of guns supplied for coast protection and their greater vulnerability to destruction by individuals or small raiding parties gaining access to a work.

In the days of muzzle-loaders a fort was armed with a considerable number of guns on very simple mountings, which it was difficult to damage effectually, and which, even if damaged, allowed of repairs or of makeshifts being employed, so that guns could continue in action. Now, on the contrary, the defense of a harbor entrance may in some cases depend on very few guns, on mountings which are particularly vulnerable below the shield, and which, if once damaged, would be very difficult, and take a long time, to repair.

Then, again, whereas formerly guns were enclosed in strong casemated forts, and could not as a rule be silenced from the land side unless the fort was first assaulted and captured, they are now usually placed in open bar-

* Garrison Artillery Training, Vol. I.

bette batteries, which may be exposed from the flank or rear to rifle fire from an enemy occupying commanding ground within range of the guns. There are also nowadays electric lights, position-finding cells, and communications, all important adjuncts of a successful defense, which are particularly tempting objectives to raiders, and the destruction of which, though not necessarily destroying the effectiveness of the defense, may seriously hamper it should vessels attack at the same time.

Yet, in spite of the very great disadvantages under which an attack on coast works from the land side had to take place in the past, as compared with the present, we find on examination of historical examples that, in almost every case of the successful silencing of coast works, this has been effected from the land side, and not by the fire of ships' guns.

COMBINED ATTACKS BY SHIPS AND LANDING PARTIES

The best results have been obtained by combined attacks by ships and landing parties, but the latter have in nearly every case been mainly responsible for the capture of the work or of the place attacked.

The capture of Fort Fisher illustrates this very well. During the American War a large fleet went in to attack it, and opened a very heavy fire upon it, but the fort made little reply.

> "Part of the reason of that was that the garrison considered that it was not of much use sinking a ship, or two or ten ships, because there were an almost unlimited number of ships in the north, and what the garrison wished to reserve themselves for was the attack by the land force. They beat off the land force on the first assault, and it was only on the second assault that the place fell."*

As more modern examples, we have the capture of Port Arthur and of Wei-hai-Wei by the Japanese, in 1894, and of Santiago by the Americans, in 1898. In each case, though the attackers were practically in absolute command of the sea, no serious attempt was made to take the forts by bombardment, but an army was landed, and the works were captured from the rear.

Still more recently we have the capture of Port Arthur by the Japanese. The majority of the Russian vessels had been seriously damaged, the free exit from the port of the remainder was to a great extent blocked, and there was at one time probably no force to cope with the Japanese fleet except the still distant Baltic squadron; yet practically no attempt was made to attack the coast defenses, and finally crush the fleet they were protecting, except by a distant bombardment from a position out of reach of the Russian guns.

The risk of approaching too close was exemplified by the loss of the *Hatsuse* and *Yoshima* on the same day through striking mines placed off the fortress; this disaster went near to seriously imperilling the Japanese command of the sea, and thereafter the Navy was content to play a waiting game while the defenses were slowly but surely attacked and taken from the land side.

SPECIAL POSITION OF THE UNITED KINGDOM

In considering the subject of land attack, there is one point which is very often overlooked—namely, that we are in an absolutely different position from any other nation in the matter of coast defense, for we are, presumably, only exposed to attack during a comparatively limited time, and

* "Naval Attack of Fortifications," by Admiral May, R. N.

if we can hold out long enough, a relieving fleet is bound to come to our rescue. If we have so entirely lost command of the sea as to possess no relieving fleet, the game is up, as, sooner or later, the British Isles must be starved into submission, and our colonies, coaling stations, etc., must fall in due course, and no amount of resistance will affect the ultimate end. We must, therefore, assume that the existence of our fleet is vital to our existence as a nation, and need only consider attacks during local or temporary loss of command of the sea.

It is improbable that an enemy will, under these circumstances, undertake a regular bombardment of coast forts, and risk damaging his ships and exhausting his ammunition, with the possibility of having to fight a naval action subsequently, nor will he have time to collect and land a large force and undertake a regular siege; but, on the other hand, he will be very much tempted to try and take certain of our coaling stations and coast fortresses by a *coup de main*, probably with a view to destruction only, and for this purpose he will employ a land force, which must of necessity be comparatively small, and is not likely to have any guns heavier than those which can be landed in boats.

These attacks will all, more or less, partake of the nature of a raid, and their success will depend upon rapidity of action and surprise.

RAIDS BY TORPEDO CRAFT

The most probable form of raid will be an attempt by torpedo craft to penetrate the defenses with a view to the destruction of ships-of-war lying within. Attacks of this nature may possibly be delivered before a declaration of war; this liability, therefore, imposes on the garrison of a port the necessity for great vigilance at a time of political tension. The nearer a port to the enemy's bases, the more liable it is to this danger, but ports out of range of sea-going boats are still liable to attack by smaller types carried or towed by battleships or cruisers. the loss of even several torpedo vessels would be amply compensated by the great damage others could do, should they succeed in running past our defenses, and we may take it for granted that the enemy would endeavor by every means in its power to assist the attack.

LANDING PARTY IN CO-OPERATION WITH TORPEDO BOAT ATTACK

This assistance can obviously be best given by a force acting in rear of the defenses, and either silencing or worrying the quick-firing guns by enfilade or reverse fire, or destroying the electric lights upon which we are dependent for successfully repelling a night attack. Under cover of darkness it should not be difficult for a resourceful enemy to put a small party ashore unobserved, and, if these succeed in getting through the troops protecting the land side, they may be able to do great mischief, will, in any case, unsettle the defenders, and in the resulting confusion, will have a very good chance of escaping.

SECRET AGENTS

Or, again, secret agents might be employed with orders to destroy lights at a given time or on a given signal. The existence of such secret agents is not always taken very seriously, but it is desirable that we should be on our guard against them, especially when we remember that many of our coast fortresses abroad are situated in places which contain a very considerable number of aliens, who are continually coming and going, and the movements of whom could not be effectually watched, even by the best police in

the world. A few well-paid agents, provided with bombs or guncotton, wherewith to destroy electric lights or engine rooms, or who succeeded in unearthing and cutting the cables joining these, might very materially assist a raid by torpedo craft. For the protection of electric lights we are dependent upon infantry who should be able to ensure that no unauthorized persons approach within bomb-throwing distance of any of the projectors or gain access to the engine-rooms.

VULNERABILITY OF EXPOSED BATTERIES

If the quick-firing guns are open to rifle fire from the rear, we must likewise depend upon infantry to watch all commanding ground, and prevent its occupation by raiding parties who may have effected a landing unnoticed. An enemy succeeding in taking up a position within 1,000 yards of an exposed battery at night could practically silence its fire; the flash of the guns would show up the detachments to him, and the demoralizing effect of rifle fire arriving from the rear would be sufficient to make accurate laying at a fast-moving torpedo boat very problematical.

The obvious remedy for such a contingency is to watch the coast line so as to prevent raiders landing, and to so guard the approaches to batteries that raiders may be intercepted, even should they successfully elude the vigilance of those watching the coast.

RAIDS AGAINST DOCKYARDS AND STORES

Next to a raid by torpedo craft, the form of attack coast fortresses abroad may most have to fear, is one having as its object the destruction of a dockyard or of the coal and stores kept in reserve for our fleet. Such a raid would only be undertaken if an enemy was in temporary local command of the sea, and, for reasons already mentioned, his object would probably be to complete the work of destruction and re-embark as quickly as possible, and before the arrival of a relieving fleet. He would, therefore, desire to effect a disembarkation at the nearest convenient distance from his objective. We may, however, take it that any good landing places in the immediate vicinity of a dockyard, although possibly not under the fire of the main batteries, would be protected by the fire of fixed armament guns.

ALTERNATIVE METHODS OF ATTACK

The enemy, therefore, has the alternative of risking some of his ships in silencing coast works in order to obtain a suitable base fairly close to his objective, or of effecting a landing at some more distant point, and advancing overland to the attack, as, for example, the Japanese did in the case of Port Arthur.

Should he select the former alternative, he would endeavor by every means in his power to silence, or render as ineffective as possible, the fire of the guns commanding the point selected as his base, without exposing his ships to more damage than necessary. The means employed to effect this might be:—

a. To destroy guns or blow up magazines by means of secret agents or small landing parties effecting an entrance into the work.

b. To destroy position-finding cells and to cut communications by the same agency, in order to hamper the defense, and to render long-range fire more inaccurate.

c. To put a small force ashore during dark with orders to take up a position on ground commanding the guns from the rear, and to pick off the gun detachments and battery commander and staff as the ships attack at dawn.

To meet the above, very carefully thought-out plans of defense are necessary. All probable landing places must, of course, be guarded by infantry but as, however good the watch kept, a resourceful enemy is pretty sure to succeed in putting men ashore at some point or other undetected, we cannot altogether trust to this first line of defense, and must take steps for the closer protection of individual works.

NECESSARY DEFENSE MEASURES

The details of defense necessary to guard against the above forms of attack are briefly as follows:—

a. Modern mountings are usually very vulnerable behind the shields. A slab of guncotton or charge of high explosive detonated at a suitable point could more effectually silence a gun than hours of bombardment by ships. Magazines stocked with cordite are no longer so easily exploded as in the time of Guy Fawkes, and more elaborate arrangements are necessary nowadays. It is, however, obviously as well not to allow anyone to exert his ingenuity in this direction.

To prevent the entry of unauthorized persons into batteries infantry guards are required, whose duty it should be to watch and patrol the approaches; the batteries themselves, if situated in old pattern forts, are usually surrounded by deep ditches, but some modern ones may have only so-called "unclimable" fences, which—as no fence has yet been invented which will stop a good climber provided with the necessary easily carried articles for surmounting it—should be further supplemented by barbed wire entanglements.

The artillery should find sentries on guns and magazines, so that even should the infantry outposts and the obstacles be passed, the attackers may be discovered and stopped.

The essence of effectual protection against such attacks is, however, an offensive defensive, and we should not be satisfied to sit down near the guns, and wait for the enemy to come and attack them.

b. Position-finding cells should be sufficiently protected by a small guard of infantry, as the value of their destruction would not be sufficient for the attackers to risk losing several men in an attempt to do so.

Communications are liable to be interfered with, either through the cutting or short-circuiting of air-lines, or the cutting of cables. As such damage would probably be carried out by individuals during the hours of darkness, it is very difficult to guard against; good patrolling and the prevention of movements of all unauthorized persons at night are the only means available. Such damage would, however, usually only affect the defense temporarily.

c. If "snipers" can be put ashore at night, and can get within range of open works, their fire at dawn would have a most demoralizing effect on the gunners; by the time they were discovered and dislodged by the defending infantry it is probable that the enemy's ships would have effected their object of closing with the work, when—with their great preponderance of armament—they might silence it at close range.

It is therefore important that all possible protection against such fire from the rear should be afforded by means of parados and other cover; and that, if the battery is commanded by any high ground, such ground should be carefully patrolled and searched by infantry a little before dawn to prevent the possibility of its being occupied by the enemy.

The difficulty of getting away again, is, however, likely to prove the best deterrent against such attempts, as, should the enemy fail to effect a landing in force, the fate of the "snipers" would be sealed, for they would usually be hunted down and captured during daylight.

MEASURES FOR OPPOSING A DISEMBARKATION

Should the enemy succeed, by fair means or foul play, in silencing the fire of fixed armament guns bearing upon the point selected for disembarkation, or should he select a point out of reach of the fire of the fixed armament, we have to depend upon infantry, supported by guns of the movable armament, to prevent a disembarkation, if possible, and, failing this, to hold such positions as will delay the enemy's advance and prevent him from effecting his object of reaching the dockyard or attacking the coast batteries from the rear.

As it is probable that an attempt would be made to put an advanced party ashore, and to capture a covering position during dark, movable searchlights at all the most probable landing places are very desirable, and infantry and maxims, supported by guns of the movable armament, should be available to oppose a landing, and to prevent the enemy from obtaining a footing on shore until such time as the local reserves—which should be kept in hand ready to move at short notice to any threatened point—can be brought up.

GUNS OF THE MOVABLE ARMAMENT

Some of the movable armament guns would probably, on mobilization, occupy positions commanding landing-places, and, if an enemy were aware, through his spies, that guns were to be emplaced, and that they covered his prospective point of disembarkation, he might endeavor to destroy them by small raiding parties during the night prior to, or in combination with, the landing of his covering force. To prevent such an attack from succeeding, guns in exposed positions should be protected by barbed wire or other obstacles, and should have an infantry escort detailed for their protection.

The guns should not be placed too near the shore, even at night, as they can do their work just as well some distance back, where they are less likely to be rushed, and are able to assist in holding a defensive position should the enemy succeed in landing an attacking force.

The landing of an enemy's force and its subsequent advance would, in all probability, be supported by the fire of ships; this fact must not be lost sight of in selecting positions for movable armament guns, and in determining how they are most likely to be employed. The heavier guns might have to take up indirect fire positions from which to engage an enemy's transports or supporting ships; but, if they are required to fire direct, they should be most carefully screened and protected, especially on the seaward flank. The lighter guns—the targets of which would be troops disembarking in boats, or infantry advancing—would usually have to fire direct, and should trust to concealment and good entrenching in order to offer as difficult a target as possible to the enemy's ships; it might, in some cases, be advisable not

to disclose their position until a good target—such as troops landing in boats —offered itself for attack by rapid shrapnel fire.

Should the enemy succeed in effecting a landing and securely establishing himself on shore, the checking of his advance and the taking up of successive positions—should a retirement become necessary—does not differ in the case of a coast fortress from similar work in the field, with the exception that advanced coast batteries or forts may sometimes serve as defended points in the case of a retirement; they should, therefore, be made as impregnable from the land side as modern fortification can make them.

The question of the land defense of coast batteries and fortresses is one that must be seriously considered during peace, and too much should not be left to be thought out and done upon mobilization. It is only by attention to what may appear, at the time, trifling and unimportant details, that "regrettable incidents" are avoided when it comes to actual fighting.

—*Journal of the Royal United Service Institution*, July, 1911.

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THE LAND DEFENSES OF HOLLAND

(Extract)

Translated from the German by CHARLES A. JUNKEN for the Journal U. S. Artillery.

COAST DEFENSE

As is well known, the Netherlands is passing through a transition period on the subject of Coast Defense. Since the draft of the bill appropriating a round 40 million guilders for increasing the efficiency of the coast defenses will probably not be materially altered by the Second Chamber, it is assumed that far-reaching improvements will be undertaken. In the following pages the project will be outlined after the present condition of the coast defenses have been reviewed.

These will be considered in the following order:

a. The position at the Helder.
b. Works protecting the sea approach to Amsterdam.
c. The position at the mouth of the Meuse and the Haring-Vliet.
d. The position at Holland Diep and Volkerak.
e. The works at the West Scheld.

a. *The position at the Helder.*

The capture of this position would provide an attacking force with a safe retreat and a safe harbor. Furthermore, possession would be obtained of various storehouses, arsenals, magazines, docks, etc. The enemy would then be master of the Zuider sea and could with comparative ease capture the position at Amsterdam. Moreover, for other reasons, the security of the Helder position is of the greatest value for the protection of Amsterdam. So long, for instance, as Holland controls the whole North sea canal an investment of Amsterdam at the North is only possible by foot soldiers along the land between Ymuiden and the Helder. But before such a massing of troops the enemy must first occupy the Helder.

Without a base of operations such an occupation is not to be considered. With this explanation, the interdependence of the two positions is clear. The position of the Helder is not only subject to an attack by sea but may expect an attack by land as well. On this account it has a coast and a land front.

The coast defenses are: Fort Kykduin, Fort Erfprins, the East battery, Battery Princess Louise, Battery Wierhoofd and Fort Harssens.

Fort Kykduin is at the top of a high dune. Its principal role is to cover the channel of the Schulpengatts, which at this place is not very broad and lies close to the land. The obsolete 24-cm. guns are not protected by armored cupolas.

North of Kykduin is Fort Erfprins, which also urgently needs armor protection. It commands the Schulpengatts, Breewyd and Helsdeur. The more easterly fortifications protect the Roads of Helsdeur and Reede. Fort Harssens alone is provided with armored cupolas. What protection, the land side has is afforded by the fortifications on the land front of Fort Erfprins, Battery Westover, the connecting line between these works and Battery Admiral Dirks and Fort Oostoever.

b. *Works protecting the sea approach to Amsterdam.*

The occupation of the harbor of Ymuiden would be very valuable for an enemy attacking Amsterdam. This harbor is protected by Fort Ymuiden, which also protects the North Sea canal locks. The fort has a seacoast battery and a revolving turret. Since the obsolete armament has a very limited range, the government has projected plans for reaching the enemy at long range by means of which we will speak later.

The armored Fort Pampus in the Zuider sea and the shore batteries Durgerdam and Diemerdam, operating with the fleet, protect Amsterdam from attack by the Zuider sea.

c. *The position at the mouth of the Meuse and at Haring-Vliet.*

The mouth of the Meuse bears very important relations to the interior; this is especially true of the new channel, which offers passage for the largest vessels. Once in possession of Rotterdam, the second city in commercial importance in the land, a landing party could threaten the whole of South Holland to the new water line in rear, or march without interruption on Amsterdam. With this in mind, there has been erected on the north bank of the new channel the armored fort on Holland Hook; it defends this channel. The fort is modern. It only lacks some minor details of equipment.

The Haring-Vliet is also a waterway of great importance. A landing at Voorne is not very probable, since the enemy would have to cross two bodies of water. However, the fortresses Brielle and Hellevoetsluis are erected here, joined by flooded areas. Hellevoetsluis is, however, of the greater importance since it covers the passage to Haring-Vliet.

These seacoast batteries must be modernized.

The fortifications at these passages will, according to the new budget, be considerably strengthened.

d. *The position of Holland-Diep and Volkerak.*

The march of an enemy's army across the Holland Diep, that broad arm of water, with its strong currents and barren shallows at low tide, would be an exceedingly hazardous undertaking. Moreover, such a thing would be well-nigh impossible if the troops commissioned with the defense should be

supported by a harbor-defense fleet in Holland-Diep. The capture or annihilation of this fleet must be first accomplished by the enemy.

In this aspect of the case, it would be of the greatest importance to the attacking force if his ships could be brought in through the Haring-Vliet or the Volkerak to the Holland-Diep, where he could support the landing party in rear during its passage across these meadows.

The object of the fortress at Hellevoetsluis and the position at Holland-Diep and Volkerak is to prevent this. The latter position consists of Fort Willemstad with outlying works and moats, the position of Ooltgensplaat at Overflakke and the fort at Numansdorp in Beierland. Quite reasonable expenditures would bring these works to the highest state of modern equipment.

e. *The works on the West Scheld.*

Although to this position no political significance applies, it must be stated that in the oft-repeated alarms of the English-French press over the erection of a fort at Vlissingen the essence of the matter is neglected.

The maintenance of Belgian neutrality is always advanced to the foreground, but Holland can only maintain neutrality by directly defending her own territory from an unfriendly attack. If the government of the sovereign Netherland States deems it necessary to fortify Vlissingen it is no one else's concern.

The West Scheld in Holland is Netherland territory and it is therefore a matter of the gravest importance that her neutrality be strictly observed. Would the aforementioned press be so vastly perturbed if Holland built blockading forts at Limburg on the Meuse? Moreover, it happens that, although obsolete, forts have already been built on the West Scheld and that Vlissingen was fortified in 1860. Have conditions since then been suddenly changed? Assuredly not. And now, as at any earlier period, the Netherlands dare allow no foreign power to march through her territory and attack Belgium, neutrality or no neutrality. At present, the fortifications at the West Scheld are the works at Neuzen and Elle Woutsdyk. They are entirely obsolete; they are without value to resist the attack of modern battleships, and the arrangement of the coast defense batteries is entirely unsatisfactory.

PROJECT FOR UPBUILDING THE COAST DEFENSES

At the outset of the development of this project, it may be stated that methods of offensive warfare and providing against possible surprise attacks on Holland's Navy demand a speedy improvement of the whole means of protection, not only in the coast defenses and blockading forts but also in the floating materials of the Navy.

The following methods should be employed:

a. Improving the defenses of the seacoast at the Texelschen seaway, the harbor of Ymuiden (at Amsterdam), the seaway of Holland Hook, the Goereschen seaway, the Holland-Diep and the Volkerak in their armament, equipment and design.

b. Improving Forts Kykduin and Erfprins by armored cupolas. The government contemplates equipping the batteries which are expected to fire on ships at extreme ranges, with 28-cm. 45-caliber guns.

c. The erection of modern fortifications for the protection of the West Scheld and the equipment of those previously mentioned.

d. The equipment of the defenses of the Vliegatten, the Zuider sea and

the waterways and bodies of water mentioned under 1, with requisite marine stores and by placing in commission

8 seagoing torpedoboats
14 armored ships
2 submarines,

and as accessories thereto the requisite number of blockading mines and the necessary magazines therefor. (Instead of the two submarines other plans are afoot; it is contemplated to provide five, using one as a reserve.)

The government proposes to place the whole matter of seacoast defense in the hands of the Navy. This will require from 600 to 1,000 men of the two-year naval militia.

Altogether there is provided 13¼ million guilders for floating material, and for coast defenses and their armament 25 million guilders; a total of 38.37 million guilders.

—*Internationalen Revue uber die Gesamten Armeen und Flotten, Beiheft* No. 130, June, 1911.

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PORT ARTHUR, 1904—THE RESULTS AT SEA

Translated from the German by Captain William F. Hase, C. A. C., for the Journal U. S. Artillery

(Extract)

The Japanese used tramp steamers in their attempts to close the roadstead against the Russian fleet. Five vessels of this class, of 3000 to 4000 tons, were loaded with stone in Japan, cement being used. Mines which were to be ignited from a point on deck, were laid in the holds; coal dust and lime saturated with oil were heaped up on the deck.

For each ship, 1 officer, 1 mechanic, and 8 men were detailed. A harbor chart of Port Arthur was supplied showing the exact position where the particular ship was to be sunk. These ships proceeded to Elliot Island and convoyed by torpedo boats sailed from there on Feb. 24, for Port Arthur. They attempted to approach the harbor entrance from the Lao side, but were discovered by the lighthouse on this hill, and then by the searchlight on the Tiger peninsula. They were met by a terrific fire from the coast batteries and the *Retvisan*. They were blinded by the searchlights and lost course and direction.

Three steamers were sunk near Wolf's Hill; another near the lighthouse at the entrance of the roadstead and the other near Golden Hill. The roadstead itself remained clear. The crews of the sinking ships entered their barges and were rescued by the torpedo boats.

In the second attempt to close the channel during the night of March 28, four vessels were used. The fire of the Russian torpedo boats, the shore batteries, and the guard boats sank these ships—three near Golden Hill and the other near the lighthouse, where one was sunk on Feb. 24.

Eight ships were used in the attempt on May 3. These were met with a hot fire from the shore batteries and the guard ships. Almost 2000 shots were fired, among them 300 shell of 25- and 22.5-c.m., and about 550 shell

of 15-c.m. How much damage this firing did is not ascertainable but it is certain that this attempt was fruitless, as no ship was sunk in the harbor entrance.

The fruitless result of these attempts to close the harbor cannot be laid to faulty preparation, or to cowardice on the part of the crews. Perhaps it was only a chance that caused one or the other ship to be sunk close to but not in the channel mouth. All accounts of these attempts emphasize the fact that it is difficult to plan such an undertaking and that one cannot count on success.

The searchlight played a most important *role* because it made navigation most difficult.

Sea mines were used by both the Russians and the Japanese in great quantities. On Feb. 11th, automatic mines were laid by the Russians in the harbor of Talienwan, as well as in the Kerr and Deep harbors to the east, to prevent landings there. Automatic mines were also laid in such parts of the harbor as were not covered by coast batteries in order to prevent the Japanese from lying in these dead angles and firing unmolested. Automatic mines were also laid outside of the harbor's mouth in such a position that the Japanese fleet would encounter them in their accustomed maneuvers off the entrance. The Russian mines in front of the entrance were controlled from the shore in order that their own ships might cross the fields safely. The Japanese torpedo boats which tried to lay mines in front of the harbor entrance on April 13th, May 30th and June 7th were dispersed by the fire of the coast guns and the guard ships.

The battleship *Petropavlosk* and a Japanese ship were sunk by mines. Many of the large ships struck mines, but leaks only resulted, so they were able to enter the harbor, even though they were temporarily rendered *hors de combat*. The smaller ships which struck mines were sunk. The Russians had to remove the Japanese mines before an attempt was made to leave the harbor in fleet formation. The Russians as well at the Japanese successfully raised the hostile mines—the latter removed all the mines in the Kerr and Deep harbors.

It is certain, however, that several disasters occurred while this work was in progress. In repeated cases, the automatic mines injured friend as well as foe. The coast guns fulfilled their function in supporting the navy. Steps were taken to remedy defects in emplacements as soon as discovered. A new battery, 22, was installed on the Krenzberg and 15-cm. Canet guns belonging to Battery 19 placed in it, because the Japanese fleet had found a dead angle in front of the Krenzberg. For similar reasons observing stations were established on the Lao-tieh Shan, to direct the fire of the ships in the harbor. Several guns of small caliber were installed to protect the mine fields of the harbor entrance. Some controversy arose between the authorities at Port Arthur and those at St. Petersburg over the supply of ammunition for the 25-cm. coast defense guns. The shells for these guns were not loaded with high explosives; therefore they were not efficient in their attacks against ships. The St. Petersburg authorities took the stand that no means of loading had ever been provided, which did not militate against penetration. The effectiveness of the shells was limited to 3.2 kilometers: using them against moving vessels at a range of over 10 kilometers would only result in waste of ammunition and in gun deterioration. The Port Arthur authorities raised many objections but without result. No other projec-

tiles were forwarded by the St. Petersburg authorities, though the fleet did turn over to the coast artillery many effective projectiles. They turned over to the coast defense authorities, also ammunition, searchlights and manning parties.

The ships of both fleets tried to assist their respective armies in the land engagements.

The Japanese gunboats did assist materially in the engagement on May 26th at the Kinchau isthmus but on the whole, neither the Russian, nor the Japanese, fleet had much weight in determining any one land engagement.

—*Kriegsteschnische Zeitschrift*, January, 1911.

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THE LOSS OF THE LIBERTE

The commission which was appointed to inquire into the disastrous explosion on board the French battleship *Libertie* has just issued its report. Briefly stated, this document establishes the following facts:—(1) That there was not any trace whatever of malevolence; (2) that the hypothesis that the explosions were caused by a fire is disproved; and (3) that the catastrophe was due to the ignition of a cartridge of powder in one of the two forward starboard magazines, and nearly certainly in the upper magazine, in which was stored powder known as B.M. 13 a.m. 8-2-06. It is also stated that all the prescribed regulations for preventing decomposition of the powder had been observed, and no blame is imputed to any of the officers and crew. It had been anticipated that some such finding would be the result of the inquiry, and it is certainly disquieting. It was thought by the French scientists that the chemical treatment to which the powder has latterly been subjected, together with a thorough system of ventilation so as to keep the temperature on the magazines as low as possible, would ensure that the explosive would not deteriorate and become dangerous. Is it not possible to say whether all the powder had been treated chemically, though some of it had; but it is clear that there was no fault to find with the ventilating arrangements. Apparently, up to four years of age the B powder can be relied upon; but it will be observed that the powder in question was made in February, 1906, and was therefore five and a-half years old at the time of the explosions. Unfortunately, as all the powder had not been treated, it is impossible to say—at any rate, with the facts before us—whether or not the chemical treatment alluded to is of any avail. We believe that this treatment consists of steeping the powder in some preparation of alcohol, and it has hitherto been considered to render the powder absolutely safe. The Commissioners endorse the precaution taken of limiting the age of the powder carried on board ship to four years, and say that for the present, at all events, this is much the safest course to pursue. The report of the Commissioners, viewed from whatever standpoint, reveals an unsatisfactory state of affairs, and it will doubtless lead to substantial changes in the composition of the propellant used in the French navy.—*The Engineer*, October 27, 1911.

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RECENT DEVELOPMENT IN ORDNANCE

Demand for Higher Efficiency Met by Our Latest Guns and Armor

By Rear-Admiral N. C. Twining, U. S. N., Chief of Ordnance

Progress in ordnance matters during the past year has been rather in the direction of improvement and development of previously existing types than in the line of marked changes. Naval warfare has not been "revolutionized," nor has any such upheaval been even faintly indicated. The increasing efficiency of the submarine boat, of the torpedo, and of the aeroplane has

Scientific American. Relative size of naval shells from 5-inch to 14-inch

The powder charge, weighing 370 pounds, discharges the 1,400-pound shell with a muzzle velocity of 2,600 feet per second, and a muzzle energy of 65,687 foot-tons. At 10,000 yards the shell will penetrate 15.9 inches of Krupp armor.

caused ordnance officials and the navy in general to look ahead to the time when the development of these weapons and methods of attack might demand changes in ordnance or in ship construction to meet them, and tentative plans for such changes have been considered. The aeroplane can not, as yet, be regarded at a material factor in naval warfare; but its possibilities in the future cannot be neglected. The submarine boat and the torpedo have long been elements to be reckoned with, and their usefulness and efficiency are on the increase.

The gun remains the principal offensive weapon afloat and armor the principal element of passive defense. The battle between the two, which has been so often declared lost or won by one or the other, still goes on; though the gun seems to have rather the better of it at the present moment. Already there are rumors of larger and more powerful guns and of armor of greater resisting power. A year ago no modern vessel built or planned carried a gun of caliber greater than thirteen inches, and all of the latest battleships were armed with guns of 12-inch caliber. Today there are numerous ships building at home and abroad which are designed to carry 13.5-inch and 14-inch guns. Armor's answer to the bigger gun is, so far, increased thickness; but new processes of heat treatment and the introduction of new alloys are rumored, which will restore the former thickness with greater resisting power.

GUNS

The "all-big-gun" battleship of the present day has its prototype in the British *Dreadnought*, dating from 1906. Since that date all the principal maritime powers have shown a tendency to confine themselves to battleship design of this type, the main battery consisting of from eight to twelve guns of the largest caliber, mounted in turrets, and the torpedo defense battery of from twelve to twenty or more guns of smaller caliber mounted in broadside.

In the United States Navy the Standard heavy gun is at present the 14-inch, 45-caliber gun, while for torpedo defense a 5-inch, 51-caliber gun is used. The following table shows the superiority of these guns over previous types:

5	40	17	3.1	2300	50	1852	7000	2.3 at 6000 yds.
5	51	22	5.0	3150	50	3439	12000	3.0 at 6000 yds.
12	45	46	53.6	2850	870	48984	22000	15.2 at 10000 yds.
12	50	51	56.1	2900	870	51644	24000	15.6 at 10000 yds.
14	45	54	63.3	2600	1400	65687	21000	15.9 at 10000 yds.

An examination of this table shows that the latest turret guns and torpedo-defense guns are markedly superior to their predecessors. The superiority of the 10-inch gun over the 12-inch, 50-caliber gun is due in part to the greater steadiness of the projectile in flight due to its greater weight. The "hitting power" of the gun is greater than that of its predecessor in spite of the fact that its extreme range as mounted on board ship is less.

On page 84 are shown the breech and breech-plug of the 14-inch gun, together with an armor-piercing shell and powder charge. The shell shown is of the latest "long point" variety, while the powder charge represents the present practice of putting up smokeless powder in silk bags laced on the side to make them rigid. An idea of the length and general size of the 14-inch gun with the slide in which it is mounted in a turret can be gained from the illustration on opposite page.

Scientific American.

All future battleships will mount the new 14-inch gun for armor attack and the 5-inch gun for torpedo defense.

The latest type of gun and mounting for torpedo defense is shown below the 14-inch gun. This gun may be regarded as effective against torpedo boats at its extreme range of 12,000 yards provided the target is visible; at night or in other circumstances rendering the target invisible, the gun is naturally helpless.

Modern high-powered guns using smokeless powder charges have been proved to have a practically unlimited life under normal conditions of firing; but they erode in the bore very rapidly owing to the high powder pressures they must sustain, and the consequently high temperatures. This erosion is probably due to the action of the powder gases on the metal of the gun as softened by the high temperatures to which it is exposed—about 4,000 deg. F. As the parts of the gun not immediately in contact with the gases suffer no deterioration, the life of the gun may be indefinitely prolonged by renewing the bore. This process is known as "re-lining" and has hitherto consisted in boring out the interior of the gun (to a depth of about one inch in the case of the 12-inch gun) shrinking in a new tube, and then boring and rifling. The facility of re-lining will be enhanced and the cost of the operation will be greatly reduced in the future by building all new guns with conical liners, susceptible of easy removal. The time of re-lining a gun will thus be reduced from seventy-five to twenty-five days.

GUN MOUNTINGS

For a number of years past rumors have been periodically current that this or that foreign country was about to incorporate a three-gun turret in some new battleship. Such advantages as such a system have heretofore presented were mainly in the direction of economy of armor weights, it being readily demonstrable that six guns can be protected with less weight of armor if mounted in two turrets than if mounted in three. There have been, however, countervailing disadvantages in the increased complexity of ammunition supply, turret machinery, concentration of weights, and other features of the system which have rendered its adoption inexpedient. The time seems now to have arrived when the necessities of ship design and tactical considerations have forced the triple turret and it is interesting to note that Russia, Austria, Italy, and the United States have all incorporated it in their latest battleship designs. It is now decided that United States battleships Nos. 36 and 37 will each carry the triple turrets as a part of their main armament. These turrets will embody certain new ideas in gun mountings which have not yet been embodied in any foreign design.

For secondary gun mountings compactness and lightness are essential, but to attain them without sacrificing the rigidity which is necessary for accurate firing requires ingenuity. The mounting for the 5-inch, 51-caliber gun, shown on page 85, is the latest type of this kind of mount which has taken concrete form.

AMMUNITION

A nitro-cellulose smokeless powder continues to be the standard propellant for use in our naval guns. It is extremely satisfactory in stability, ballistic characteristics, and keeping qualities. Powder of the same characteristics and composition is used by the army and it may be safely claimed that there is no better smokeless powder in the world. This powder consists essentially of cotton dissolved in nitric acid, then dried, colloided, and pressed into the desired form of grain.

The colloided material is placed in a press, from which it emerges in long strips and rods. These are then cut up into short lengths of the particular size for the powder grain desired. The grains are of different sizes for guns of different calibers, being larger, of course, for the larger calibers. Certain varieties of black and brown powder are still in use for loading shell or for saluting purposes. The prismatic brown powder was the immediate predecessor of smokeless powder.

The navy powder is manufactured in lots of from 25,000 pounds to 100,000 pounds, depending on the caliber of gun for which it is intended. Methods of manufacture have been so perfected that these powders, when not unfavorably affected by climatic and other unfavorable conditions, retain their qualities and are serviceable for from twelve to fifteen years. In case deterioration occurs due to such conditions, ample warning is given by the physical appearance of the powder, so that no spontaneous explosion or combustion is ever to be apprehended; it is, in fact, extremely doubtful whether spontaneous combustion is possible, unless the powder should be subjected to adnormally high temperatures.

Powder which has changed in character to such an extent as to reduce its ballistic value is now re-worked and made over into new powder of the best quality at a small cost. The re-working consists of grinding the grains in water, drying the resulting paste, and then pressing it into rods or ribbons as required; the methods pursued are much the same as those used in original manufacture.

Smokeless powder possesses many points of superiority over black or brown powder; one of the best known is the fact that its combuston produces but little smoke; such as is produced is largely gaseous in nature, containing very little solid matter, and it is, therefore, quickly dissipated. This fact gives to the use of smokeless powder a great tactical advantage for military and naval purposes. A second point of superiority lies in the fact that the combustion of smokeless powder is practically complete, there being an exceedingly small percentage of solid residue remaining; the whole mass of the powder is, therefore, converted into gas, the expansion of which imparts velocity to the projectile.

The particular form of grain in use for all guns of large caliber is what is known as the "multiperforated" form, in which the cylindrical grain is pierced by a number of longitudinal holes. When such a grain is ignited the burning progresses both from and toward the center with the result that the burning surface is practically constant until the grain is entirely consumed. In consequence of this fact the volumes of gas produced in any two units of time while the projectile is in the gun and traveling toward the muzzle are nearly equal, and the maximum pressure on the walls of the gun is not so much greater than the mean pressure as to require that the breech of the gun be made enormously heavy as compared with the chase and muzzle, as was the case with guns designed for use with quick-burning black powder.

The quality of projectiles is being slowly but surely improved. The possible range has been increased by changing the form of the head from the blunt type in general use in recent years, to a long, sharp ogival. The illustration on page 85 shows the present type of shell for guns of 5-inch to 14-inch caliber. The point of the shell, in all except the 5-inch, is a separate piece from the remainder of the shell and is made of soft steel; the body of the shell is of very hard and tough forged steel, containing alloys of nickel, chrome, va-

nadium and other metals. It is in the quality and composition of the steel used, and in the methods of treatment, which give the shell hardness without brittleness, that the principal improvements have been made in recent years. These points are, in the main, manufacturers' secrets, not disclosed even to government officials.

The function of the soft steel cap is to support and guide the hard point of the shell and thus enable it to "bite" and penetrate the armor on impact. The addition of this very simple device to steel shell increases their penetrative efficiency fully 20 per cent. Such caps have been in use for a number of years; it is only their form that has been recently changed.

High-explosive bursting charges are a necessity in modern armor-piercing shell. The walls of these shell must be very thick in order that the shell may withstand the terrific shock of impact on armor and that it may penetrate; the interior cavity is thus too small to contain a sufficient amount of "gun powder", as commonly understood, to disrupt the shell. The use of a more powerful explosive is, therefore, necessary.

As an alternative to the adopted method of attack on armor, *i.e.*, by means of a projectile designed to penetrate and explode inside, the method of attacking with shell exploding on contact has been suggested and has been strongly urged by some persons of undoubted knowledge and attainments. The latter method depends for its efficiency on smashing or displacing the armor by the force of the impact and the intensity of the resulting explosion. Experiments have been made along these lines from time to time, but, while the damage done to an armor plate by the detonation of a quantity of high explosive in contact with it is admittedly great, it has not yet been demonstrated that a charge of any explosive which can be safely fired from a gun can effect as great damage in this way as can be effected by detonating inside a vessel an equivalent charge of explosive which can be so fired. The *Puritan* experiments only confirmed the official opinions previously held on this point.

TORPEDOES

The torpedo continues to be held in great favor as a weapon of underwater attack, and it must be admitted that no navy has at present an adequate system of defense against such attack if efficiently delivered. Torpedo nets as carried by the vessels of some foreign navies are ineffective, since torpedoes have been designed which can cut, penetrate, or displace the nets. The searchlight is ineffective, since a torpedo may be successfully launched at a range beyond its reach. Gunfire is ineffective against an invisible target, and the torpedo boat can launch its weapon while still invisible to the gun. Pickets and scouts are not thoroughly effective, since they may, themselves, be attacked and disabled, or they may be eluded. The practical torpedo of the present day may be effectively used at a range of 8,000 yards; a range of 10,000 yards at 27 knots speed is confidently expected in the near future. The United States Navy now has in course of building two types of torpedo which will, beyond a doubt, fill these conditions and may exceed them. The reliability of the torpedo in the hands of the general service is, unfortunately, still questionable and many failures and wild shots are to be expected. There is, however, nothing mechanically impossible in the conditions of the problem of making torpedoes reliable, and recent advances in this direction justify the hope that in the near future a thoroughly accurate long-range weapon will be produced.

Scientific American.

Krupp plate of 1905, after attack by three armor-piercing shells. No perforation, but excessive flaking of hardened face.

Scientific American.

Krupp plate of 1911, after attack by four armor-piercing shells. No perforation and practically no flaking of surface.

The *Vesuvius*, built for discharging so-called aerial torpedoes, is now employed at the Newport Torpedo Station as a torpedo testing vessel.

ARMOR

There has been no important advance in quality of armor since the Krupp process of hardening was introduced about fourteen years ago; during this period the side armor belts of our battleships have been of from nine to eleven inches thickness. To meet the increasing power of guns and penetrative effect of projectiles, a tendency toward increasing this thickness to twelve or thirteen inches is evident, and the Bureau of Ordnance has even had one experimental eighteen-inch plate made and tested with a view to possible future demand for armor of that thickness.

That the art of armor making has not stood still, in spite of there having been no radical changes in methods, is shown by the two photographs on page 89. The former shows an armor plate produced in 1905, and the latter a plate produced in 1911, against each of which three projectiles have been fired. In the one case the flaking of the hard surface was excessive, in the other almost *nil*. It will be noted that neither plate was completely penetrated.

Thin plates, which are not technically classed as armor, have been much improved in resisting power by changing the alloy used; a nickel-chrome-vanadium alloy has been adopted, and this when specially treated produces turret and conning tower tops of great resistance.

EXPERIMENTAL WORK

Much valuable information has been obtained by experimental firing at the U. S. S. *Katahdin* and *San Marcos* (formerly *Texas*). Each of these is a vessel of small military value, but capable of affording an actual target for experimental firing. The *Katahdin* was fitted with armor plate targets erected on her upper deck; one target represented the side of a battleship, the other a turret barbette, and in both the armor plate was braced by appropriate framing and structures. Firing was conducted with a 12-inch gun on board the U. S. S. *Tallahassee* at ranges of 7,700 to 8,500 yards, using service ammunition, but not with explosive shell, as the object was solely to determine penetrative effect. Two hits were scored on each target with resultant complete penetration of the armor, as was expected in accordance with theoretical calculations. The results of this test also proved that a projectile while in flight is at all times tangent to the trajectory.

The *San Marcos* furnished a target for more extensive firing, the greater part of which was conducted by the U. S. S. *New Hampshire* for purposes of gunnery training of the personnel. The most striking lessons of this firing were:

1. The fact that, at ranges of 10,000 and 12,000 yards, the *New Hampshire* could place her shots on any portion of the ship at will, thus proving the accuracy of her spotting and pointing.

2. The tremendous havoc wrought in the *San Marcos* by the passage or bursting of entering shell.—*Scientific American*, December 9, 1911.

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THE GUN TRIALS OF WARSHIPS

The keen interest which is generally evinced in novel departures in naval construction is perhaps most intense on the part of gunnery staff of the Royal

Navy, and thereby, from the nature of its service and the essential reticence demanded of that staff, less appreciated and understood in circles outside the Fleet. A battleship can be seen and photographed in harbor, the superficial results of machinery trials are often published, and both, from the extent of the commercial interests involved in their manufacture, are subjects of wider public knowledge than is gunnery work, in which the scope of interests involved, outside the service, is far more limited. Accurate details of the gun trials of warships are seldom to be found in print—we except, of course, the official publication relating to the order in which the vessels of the various squadrons stand in relation to one another for the annual firing tests—and the reasons are not far to seek. The obvious military secrecy necessary, and the fact that all trials are conducted by a purely naval party, are rightly and almost entirely responsible for this state of affairs.

Different, indeed, from what it was ten years ago is the Admiralty system for testing armaments. At that time a contract-built and even dockyard-built battleship proceeded on speed trials without the guns being fitted on board, and these might not be finished by the armament contractors for some considerable time afterwards. Today the armament must be in full working order on board before the main machinery trials are carried out. In fact, large gun-mountings undergo much more elaborate trials to ascertain the correctness of working of all the composite parts—hoist, rammers, elevating and training gear—both in the shop and on board prior to ship trials than any af the main propelling machinery is ever subjected to, except in very occasional experimental cases. The object of the gun trials now carried out is less of a trial of the gun and of the working of its mounting than of the effect on other parts, and especially on the ship as a whole. Generally speaking, the trials of the first of a class are somewhat more drastic than those of the succeeding vessels. When it comes to an entirely new departure such as the *Dreadnought*, *Indomitable* or *Orion*, elaborate trials to determine the effect on the ship's structure are very necessary.

The concussion produced by the discharge of big guns is tremendous; it is felt perhaps less inside the turrets than anywhere else. It is not the axial spurting flash that creates the shock so much as the radial discharge of gas which occurs as the projectile leaves the muzzle, and this effect can be very serious to anyone standing too closely at right angles to the gun. Under certain circumstances, considerable damage may accrue to the ship firing big guns on too extreme a bearing, and in new ships this amount is invariably tested, both for temporary and permanent deflection. It is generally more superficial than serious. Attention has recently been drawn to this by the gun trials of the *Orion*, about which exaggerated reports have appeared in the daily Press. As is well known, the vessel is the first of her type to be fitted with ten 13.5-inch guns arranged in five center line turrets, which are so disposed that Nos. 2 and 4 are able to fire over Nos. 1 and 5 respectively. No. 3 is arranged between the two superstructure erections on the upper deck and can fire about 60 degrees before and abaft the beam. In or on these lightly plated superstructures, which are also necessary for housing very numerous essential portions of a battleship's outfit, are placed the 4-inch anti-torpedo boat guns. It has often been a question whether, in order to be clear of the large guns, these small weapons should not be placed as they are in the *Delaware* class of the United States navy, on the main deck, in which case, however, they lose some of their command and largely also their ability to be

worked conveniently at sea. On the other hand, an auxiliary armament placed as it is in the *Orion* is extremely likely to be affected by "blast" on extreme trainings. This is not the case in the *Delaware*, or the earlier Dreadnoughts, but in the *Orion* class there is a distinct tendency for this effect to be excessive.

As regards damage to the ship under these conditions opinions vary to some extent. Broken glass, ripped planking, or damaged boats are of very small consequence in war time; in peace time they are an accepted nuisance. But the extent to which they occur is comparatively small. A ship is naturally shaken considerably by the simultaneous discharge on one broadside of ten 13.5-inch guns, each of which fires a 1250 pound projectile with a muzzle velocity approaching 3000 feet a second. Such a volley is probably an exception in the life of a ship. In action it is very doubtful if it would be the best method of destroying hostile vessels. Supposing, for instance, one gun fired a fraction of a second before the other, the recoil would throw the second one off the target, and a miss would result. To fire one gun of each turret in succession is probably a method by which greater accuracy results, as the range can then be spotted more quickly and corrected for the later shots. As with such a system one gun could be fired, say every six seconds, even if the first two shots missed, then by correcting the range from their splash half of the remainder—four in all—would hit, and it is very doubtful if the target would survive a second salvo. Even if the rate of fire were twice as long, and a hit a minute only obtained, the consequences to the ship hit would be appalling. The average number of twelve-inch hits per gun per minute taken over a period of ten years is .55 as the result of gunlayer's tests; this is equal to eleven hits per two minutes. If the peace-time target practice can be even nearly approached, an action would last a tenth of the time that the battle of Tshushima took.

Even this accuracy of practice in service does not get over the concussion difficulty, but it must be remembered that extreme angles of training are provided only for purposes of emergency and for convenience in some cases. Exactly what applies to the trials of H. M. S. *Orion*, applies to the first eight German Dreadnoughts to a vastly greater extent. The United States ships, on the other hand, avoid this difficulty almost entirely by using the main deck for anti-torpedo armament, an arrangement which has often been advocated in this country. Some regard the method of placing the guns of the United States battleship *Michigan* as ideal—two center line superposed turrets at each end of a center 6-inch upper deck battery. With adequate fire control and accurate shooting, such a design might be made to comprise 15-inch guns with 6-inch anti-torpedo weapons. If such a primary gun were ever seriously considered it would involve a tremendous vessel to carry ten on the center line, and the side turret scheme adopted in the earlier Dreadnoughts has definitely given place to the center-line idea for reasons that are as equally applicable to any larger caliber weapon than a 12-inch. And if the larger vessel is to be entertained, at least a 6-inch gun will be required to deal with the concurrent increase in size and speed of torpedo craft. Probably, however, we shall see the re-adoption of the 6-inch gun long before the arrival of the 15-inch. Many of the fittings damaged on gun trials are of no serious importance. To fire a simultaneous 12-inch discharge across a deck generally causes some depression, but it must be remembered that warships are built to fight primarily, and in action it is better to fire even if some damage results; the shell will do more harm than the concussion.

Cruisers of the small and pre-Dreadnought type suffer little or no inconvenience, but they carry only lighter weapons and the hull is strong in proportion. Moreover, their anti-torpedo guns are differently arranged from those in the battleships, and it is only with the latest types that the fitting of the decks with turrets and the space occupied by the necessary sweep of the guns for all-round training has introduced any difficulty in finding space for the secondary armament. That it presents a distinct difficulty is very certain.

When we come to destroyers, where gun trials equally form one of the necessary acceptance tests, a frequent occurrence is the springing effect of the entire gun and mounting on the deck owing to the extremely light plating. Naturally the deck is stiffened in the beginning, but frequently this is not sufficient, and an extra amount is often required. The blast effect in this class of boat is virtually non-existent. In some of the earlier foreign ships the effect of this interference was really very serious, as it prevented the use of portions of the secondary armament, which at that time was regarded in a very different manner from what it is now. A glance at a Naval Annual will reveal the types referred to. In the case of the British Dreadnoughts it is only the minor guns that are referred to; the main armament does not interfere with itself in any way. The principal objection to main weapons interfering with small is that in action against a hostile fleet which possesses destroyers some portions of the main armament might have to cease firing in order to allow the small guns to be used. It will be interesting to see what modifications will be made in the next ship of the type.

—*The Engineer*, November 3, 1911.

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GEARING WITH STEAM TURBINES

The most interesting advance dealt with by Sir Charles Parsons in connection with the steam turbine, is the employment of gearing for the transmission of large powers. It is remarked that gearing promises to play an important part in war vessels for increasing the economy at cruising speeds. The difficulty in obtaining good economy at the high-pressure end of marine turbines is referred to, and it is suggested that in replacing such portions, by geared high-speed turbines, we have a complete solution. The Turbinia Company, says the author, are now constructing two 30-knot destroyers of 15,000 h.p., wherein the high-pressure portion and cruising elements are geared in the ratio of 3 to 1 and 5 to 1 respectively to the main low-pressure, direct-coupled turbine. Their use will increase the radius of action of the vessels at cruising speed to a very considerable extent over that of any similar destroyer without gearing. Similar gearing is proposed for warships, with similar prospective advantages. Gearing may also find a place in cross-Channel boats and liners for the high-pressure portion of their turbines, but the greatest material gain will be in extending the use of turbines to vessels of slow speed. Gearing enables very high co-efficients to be used in marine work at full speed, and good co-efficients at all speeds without much increase in weight, and under such conditions a geared high-speed reaction turbine is much more efficient at the high-pressure end than multiple impulse wheel or

wheels, and will probably dispense with their use generally. Gearing in marine and land work promises to give to the turbine a level consumption curve like that of the gas and oil engine. Half a century ago nearly all screw vessels had mechanical gearing, one element being composed of wooden teeth, for gearing up the speed of the engine. Subsequently the speed of engines was increased, and gearing abandoned. Now a very slow-speed turbine is an impossibility, and accurately cut steel gearing seems to be a permanent and satisfactory solution.—*Page's Weekly*, Nov. 10, 1911.

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THE GYRO-COMPASS

For nearly a century the gyroscope remained nothing more important than an interesting, scientific toy, studied with interest by many, and with patient assiduity by the few who saw possibilities of practical usefulness in its peculiar properties, but in recent years it has been succcessfully applied in many ways. It has amplified the scope of torpedo work by the systematic introduction of gyroscopic automatic steering. It has been used for automatic prevention of rolling of ships at sea, and for obtaining stability in the Brennan mono-rail train; and Mr. Brennan is at present making the gyroscope the subject of much patient investigation as a means of attaining automatic stability of aeroplanes when in flight, with what degree of success we have yet to learn.

Perhaps the application which is most interesting of all is that recently made in the gyro-compass. The details of this new and extremely ingenious instrument, as exhibited in the Anschutz gyro-compass, have been made public at the meetings of the Institution of Naval Architects and the British Association. Curiously enough, although the gyroscope was first applied to this purpose twelve years ago, in an attempt to find a substitute for the magnetic compass for use in polar regions, where directive magnetic force constantly decreases as the magnetic pole is approached, it is for this purpose almost as inefficient as the magnetic compass, for the same defect is inherent in the gyroscope as in the magnet when the poles are approached. Foucault pointed out long ago that the gyroscope would always tend to set itself with its axis of rotation parallel to the axis of rotation of the earth itself, and so in the plane of the meridian, at any place on the earth's surface except at the poles. It follows that its directive force must gradually decrease as the poles are approached, as is the case with a magnet, but from a different cause. In one case magnetic force acts at an increasing angle to the horizontal until above the magnetic pole, there is no moment in the horizontal plane, and consequently no directive force; in the other the effect of gravity on the gyroscope has a decreasing moment to produce the precessional movement upon which the directive action of the gyroscope depends for its accuracy, until at the center of rotation of the earth at its poles the moment disappears altogether. Against this must be set the fact that the gyro-compass has a directive force fifteen times as great as a magnetic compass, so that it has an advantage in that way. The great superiority claimed for this type of compass is that it is entirely unaffected by the injurious action of free magnetism, which is always found to a greater or less degree on board ship. It is not claimed for the instrument that it will make a very insistent appeal to the owners of merchant vessels, except perhaps in the case of very large liners.

In merchant ships free magnetism can be easily corrected for by the usual well-known methods, and now that electric light installations are so arranged as to preclude any fear of interference from that source, only the magnetic change which is occasionally noted on a new ship after her first voyage has to be met. It sometimes happens that a ship acquires magnetic properties during building operations, which alter in amount, or are completely dissipated, after the rough and tumble of a sea passage, but this is always carefully looked for and corrections applied by the compass adjuster. Large funnels subject to alternating conditions of heat and cold are said to have a changing magnetic effect on the compass, and it is also suggested that there are magnetic forces set up by large bodies of iron ore in some parts of the coast line which produce deviation of the needle; neither of these contentions is, we believe, well established, but if there be such causes of variation, the gyro-compass effectually avoids them. There are no doubt troubles inherent to the design of the gyro-compass itself, and there is slight error due to latitude, and direction and speed of ship, for which, however, corrections may be made. The strongest appeal is made in the case of warships, where there are large masses of metal in immediate proximity to the navigating bridge; heavy gun shields and barbettes are always near, but they are static. The worst feature is the presence of heavy guns which are movable, and for which no adequate correction can be made, except by placing the compass as high and as far from the guns as possible; this has its obvious disadvantages in exposing the instrument to gunfire. The gyro-compass is not only unaffected by magnetic forces, but for security in action can be placed in a protected part of the vessel, the motion of the compass card relatively to the ship being transmitted electrically to distant dials at convenient places. There can be nothing but generous appreciation of the care and cleverness which have gone to produce this beautiful instrument, the difficulties in design of which must have been enormous. One of the most ingenious features in it is the method by which the air currents inevitably produced by rotation of a fly-wheel at 20,000 revolutions per minute are utilised to damp out automatically the processional movement about the meridian, so that the compass finds its position of equilibrium with its axis in the true meridian after running for about 1½ hours, instead of oscillating for an indefinite period until the surface friction of the float surfaces against the supporting mercury have absorbed the momentum of the compass.

What may prove to be the particular trouble in actual service it is difficult to say. Mr. Elphinstone, who expounded the principle of it to the members of the British Association, said that, "of course it had troubles of its own," and it is certainly not nearly so simple as a plain magnetic compass. The feeling of merchant shipowners will probably be that the advantages offered to them are not sufficient to warrant installation of such an elaborate instrument, and they will be inclined to wait until there is more experience of it on service before considering the matter seriously. The cost, too, being very much higher than that of a magnetic compass, will be prohibitive until much more urgent necessity is shown for its adoption in merchant ships even of the largest size, but for warships the matter is on quite a different footing, and the economical aspect of the case will not weigh much with naval authorities if the decided advantages to them which are claimed for the compass materialise in practice.

—*The Engineer*, October 13, 1911.

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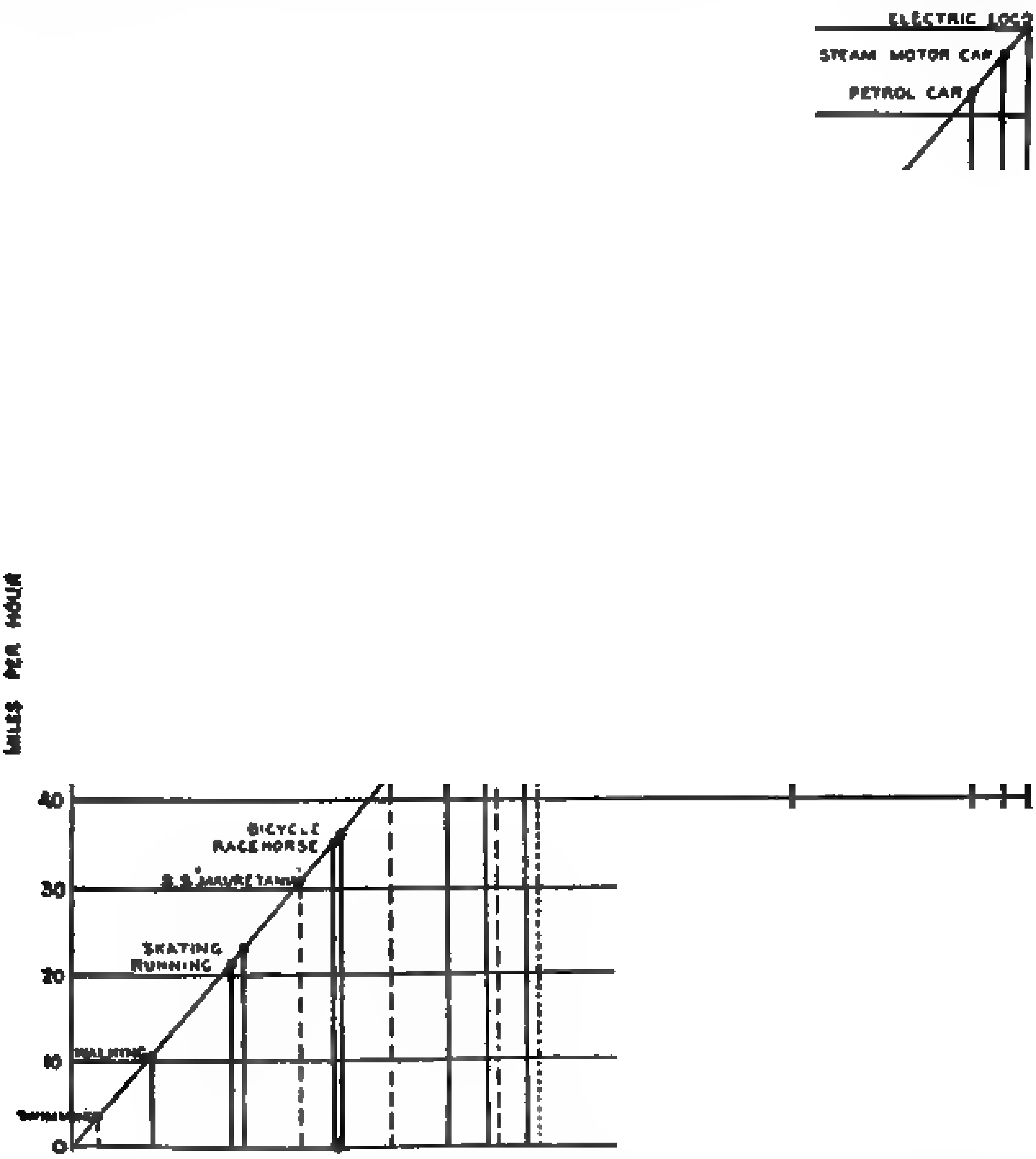
RECORD SPEEDS IN AIR, ON LAND AND IN WATER

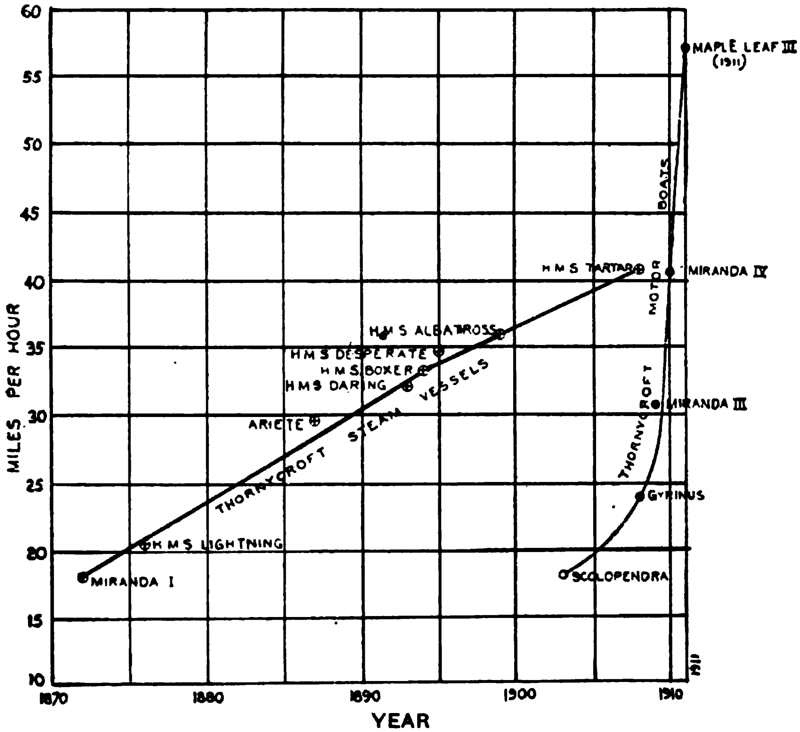
Two papers of great interest—both summaries of engineering progress—are to hand from the Royal Institution. In one of these Professor H. S. Hele-Shaw, LL.D., F.R.S., discusses "Travelling at high speeds on the surface of the earth and above it." The other paper, by Sir Charles A. Parsons, K.C.B., D.Sc., is devoted to "Recent advances in turbines." Professor Hele-Shaw includes a number of instructive diagrams, several of which we



An interesting speed chart by Professor Hele-Shaw

reproduce. We are reminded that in all three forms of locomotion—earth, air, and water—the advance has been far more rapid during the last few years than ever before, and a considerable margin is indicated by which speed of travelling could be increased as the demand for it is made. "Today," says Professor Hele-Shaw, "we can replace the muscular energy of man by almost unlimited mechanical power, and the comparative speed chart below indicates the enormous advance in the speed record which has been made over the best

unaided muscular efforts of any animal. It is curious to see that the highest speed ever attained on a railway is closely approached by that obtained with motor vehicles. The records for the latter are as follows: The Darracq car of 200 horse-power has gone 122½ miles an hour for two miles. A Fiat car, driven by Nazarro at Brooklands, 126 miles an hour. A Stanley steam car, 127 miles an hour, and a Benz car has done 127½ miles an hour. The maximum recorded speeds of a railway were on the experimental line of Messrs. Siemens, on the Berlin-Zossen High Speed Railway, where a speed of rather more than 130 miles an hour was attained. The electric current employed was 10,000 volts, 400 horse-power motors being used. On the Marienfel-Zossen experi-



Speed records afloat

mental line, the speed attained with 250 horse-power was apparently rather less, though in that locomotive four motors were employed, the current being, as in the other case, 10,000 volts.

The foregoing are the record speeds so far obtained of mechanical locomotion, and it will be interesting to see what are the record speeds attained in the other elements. Until the other day the speed on water, which has never been exceeded, was that of the ill-fated turbine boats *Viper* and *Cobra*, of about 43 miles an hour. The ship which at present holds the record for speed is the torpedo boat destroyer *Tartar*, built by Messrs. J. I. Thornycroft & Co., Ltd., this, under Admiralty tests, giving a speed of 41 miles an hour. The next diagram shows in an interesting manner what the progress in speed

has been for this class of boats during the last few years, and may be taken as typical. This, however, has been put in the shade by a boat which, though corresponding in some respects with previous hydroplane boats, has been designed by Sir John Thornycroft to possess a certain amount of seaworthiness. The rate of progress in the increasing speeds in this class of boat is shown on the separate curve, from which it will be seen that the celebrated *Miranda* held as a hydroplane the record with the *Tartar* for speed, the *Ursula* also holding the record of about the same speed as a motor-boat. Recently, however, the new boat *Maple Leaf III.* has attained the extraordinary speed of nearly 50 knots, that is to say, a speed approaching 60 miles an hour, using 600 horse-power to effect this speed, This certainly eclipses all previous records for speed."

Discussing flight records, the Professor remarks that while on land the speed has been far exceeded of the fastest animal, on water it has probably only recently surpassed that speed, while in the air, in all probability, it is still considerably below it. We must not, however, from this argue that flying speeds will for safe flying machines rise so far beyond that of birds as land locomotion has risen above the speed of animals, for it looks as if the speed records on land would be at least equal for some time, if not greater, than that possible with safety in the air. At the same time, there is no doubt that speed is the one great factor of safety in flying, and aerial speed records are sure to on go rising year by year.—*Page's Weekly*, November 10, 1911.

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THE BALLOON AS A WIRELESS TELEGRAPH RECEIVING STATION*

By P. LUDEWIG

As very little has been published regarding the wireless stations which are fitted on balloons, the author determined to describe some tests on this subject made by him at the beginning of the year. The object of these tests was to pick up with the simplest arrangement of apparatus the waves sent out from wireless land stations.

The crux of the problem lay in the arrangement of the antenna, which was made in two parts, between which the receiving apparatus was connected. As regards the receiving apparatus itself, a choice was made of those employed in practice.

The following was the arrangement employed: When the balloon was half filled a wire was wound round the equator of the gas bag, being interwoven through the protecting cordage; and the end of the wire was placed in the basket. This wire formed the upper half of the antenna. To form the lower half a heavy wire was dropped from the basket after the balloon had risen. Fig. 1 shows the completed arrangement.

As the object of the tests was to discover with how simple means picking up of messages was possible, a very simple apparatus was chosen. A Schlömilch cell was used as receiver, and this was connected direct to the antenna. as shown in Fig. 2, in order that the room taken up should be as little as possible. With this arrangement accurate tuning was, of course, impossible. Approximation to the wave length of 500 meters at the sending station was obtained when the wire from the basket was 125 meters long, or equal to $\lambda/4$.

* Abstract of an article in the "Physikalische Zeitschrift".

The choice of some simple receiving station also solved the problem as to whether damped or undamped waves should be used for sending, the small tuning capacity of the receiving station making the use of the first-named a necessity. As sending station the 30 m. (100 feet) high "T" antenna at the Electrotechnical Institute of the Frankfort Physical Society was used. This station employs the Braun method, highly damped waves with close coupling being used.

During the first tests in March, 1911, which lasted two hours, the balloon was 50 km. (31¼ miles) away at a maximum height of 600 m. (2,000 feet) from the ground. At this height the signals received were not so clear as when the balloon was lower down.

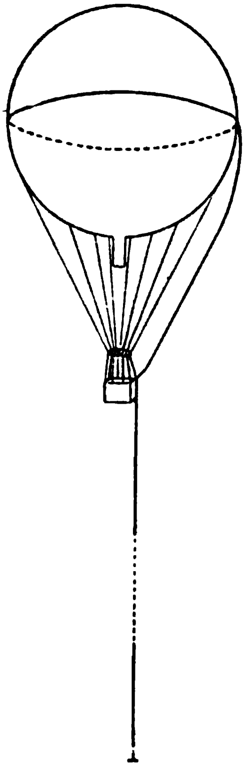

FIG. 1.

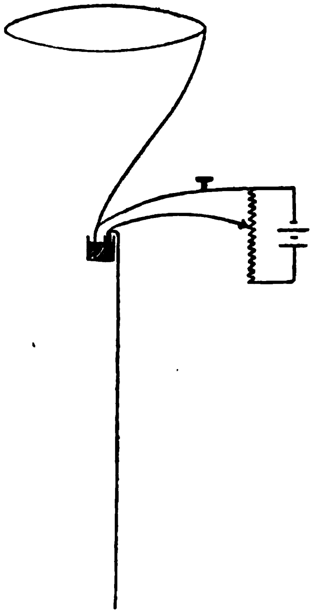

FIG 2.

During a second test on March 23rd three balloons were used, the stations at Göttingen, Darmstadt, Karlsruhe and Frankfort being employed for sending. The first three of these transmitted singing sparks, the latter working on the Braun system with a frequency of 50. The signals from Frankfort and Darmstadt were heard quite easily, but the other two could not be heard. During the time Göttingen was sending, signals with a frequency of 50 were received, and a message was received so quickly as to be unintelligible. Subsequent inquiries show this to have been transmitted from the balloon belonging to the Telegraph Battalion at Coblentz.

—*The Electrician*, October 6, 1911.

PRIZES FOR MILITARY AEROPLANES

The present war in Tripoli has greatly strengthened the interest displayed by the Italians in the possibilities of the aeroplane both as a means of reconnaissance and as a weapon of offense. Its value in the former capacity has been proven beyond a peradventure. In spite of the rapidity of its passage above fortification lines of troops, trained observers are able to obtain not only clear mental impressions of the details of arrangement. but they also have time to secure sketches and photographs, while their speed and the great altitudes at which they can fly render them practically invulnerable.

The recent maneuvers of the French aviation corps at Verdun were considered by military experts to have been brilliantly successful. Three aeroplanes, following two different routes, flew from the fortress of Verdun to the town of Tours, which was supposed to be in a state of siege. The machines covered 115 miles without descent, flying so high (from 3,000 to 5,000 feet) as to seem mere butterflies. Their observers noted every detail of the defensive works and the movements of tropps, while they could easily have destroyed the captive balloon, which was the only measure of defense taken against them.

Besides its many apparent advantages, one authority mentions, also. that this means of scouting is more humane than older methods, since fewer scouts are needed, and their probable loss of life is far less.

As a weapon of offense, however, the aeroplane is still in a state of development, and there are divergencies of opinion as to its ultimate effectiveness. Capt. Hildebrandt, the well-known German expert, is of the opinion that it can never take the place of the dirigible in destructive operations on a large scale. But the enormous comparative cost of the dirigible, with its greater vulnerability, and the difficulties of control when landing in boisterous weather. operate against its use, and give an impetus to the efforts being made to increase the offensive potentialities of the aeroplane.

An important step has lately been taken toward the furtherance of this aim. In a formal letter to the President of the Aero Club of France, a fund of 150,000 francs ($30,000) has been proffered by MM. Michelin to provide prizes for successful bomb-dropping from aeroplanes. The fund provides for four prizes. To win the first prize of 50,000 francs the aviator must carry five projectiles weighing 44 pounds each; must fly at a height of 650 feet or more; and must place his missiles, one by one, within a circle having a radius of only 32.8 feet. The prize will be awarded to the contestant placing the largest number of projectiles in the circle during a single flight. The second prize, of 25,000 francs, is to be won by the man who, flying at a minimum height of 3,280 feet, shall place the most projectiles within a rectangular area of 328 x 32.8 feet. The time limit for these two prizes expires August 15th. 1912. The limit for the remaining prizes is extended to August 15th. 1913. and the donors reserve the right to modify the conditions for these.

The results of the contests for the new Michelin prizes will be awaited with much interest especially since an American officer. Lieut. Riley W. Scott. has gone abroad with his bomb-dropping apparatus (described in our last issue), which is to be entered in competition.

—*Scientific American*, November 4, 1911.

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AVIATION AND ARTERIAL PRESSURE

The constantly increasing application of the aeroplane to such practical uses as cross-country flying, and delivery of letters and parcels, the location of submarine boats and mines by reconnoitering above the water (a feat recently successfully accomplished in France), and the carrying of passengers, directs attention anew to the importance to the aviator of an exact knowledge of the powers and the limitations of his own body.

Marvelous as is the human machine in its powers of recuperation after injury or strain, it has the disadvantage that it cannot be reassembled when once shattered, and worn-out portions cannot be replaced by new ones ordered from a factory—facts that reckless young aviators are apt to ignore.

Of especial importance is it to the aviator to know the condition and capacity of his heart and arteries, because of the severe strain put on them by the rapidity of movement, the fluctuations of air-pressure, the concentration of attention demanded, and the ever possible violent excitement of sudden danger.

If "the motor is the heart of the flying-machine," the heart is the motor of the human machine, and in either case a defective motor is the gravest source of catastrophe.

Altitude flying has a peculiarly disturbing effect on the heart, not only because of its intimate association and co-operation with the lungs, but because of the variations in arterial pressure produced by changes in the density of the atmosphere, and the fact that the tremendous rapidity of ascent and descent does not afford time for the proper adjustment of the internal to the external pressure. It has been said that the torpor which affects some aviators in too swift ascent or descent, and which is held responsible for many fatal accidents, comes from insufficient responsiveness of the arteries to changed pressure conditions, and this is easy to comprehend, since whatever affects arterial pressure must affect the supply of blood to the brain.

In this connection a very curious and significant discovery has just been announced by Dr. P. Bonnier. It has long been known that the *medulla oblongata*, the bulbous mass of gray and white nerve matter situated at the top of the spinal cord, governs the involuntary actions of heart and lungs. This is the reason why injuries to the neck are so uniformly fatal in nearly all instances, while life may be prolonged for years when other portions of the spinal cord or the brain itself have been injured. Dr. Bonnier has now shown the existence in the *medulla* of manostatic centers whose function it is to produce an equilibrium between the interior pressure of the blood and the exterior pressure of the atmosphere.

Furthermore, in subjects whose arterial pressure is supernormal because of defective action of the nerve centers, he has proven the possibility of rousing the activity of these by means of a very simple operation, consisting of a slight nasal cauterization at a point connected with the area of the *medulla* where the centers in question are found.

The return of the arterial tension to the normal following the operation is often immediate and seems to be permanent, though judgment must be suspended on this point until the early experiments are confirmed.

However, Dr. Bonnier cites one case of greater interest—that of a young man who suffered from circulatory oppression and dizziness at each descent. His arterial tension was regulated and reduced from 22 to 16, a tension which

has been normally maintained ever since (a period of four months at the time of writing), with the result that he has experienced only a slight discomfort in place of his former oppressive sensations during descent.

Thus it would seem that in some instances, at any rate, the aviator may be able to control his arterial tension and "regulate his manostatic capacity with as much care as his motor."

—*Scientific American Supplement*, No. 1871, Nov. 11, 1911.

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MILITARY AEROPLANES

The difficulties in the way of rendering an aeroplane a thoroughly practical machine have been strongly emphasized during the trials of military types held at Rheims during the past month. Even in its present form the aeroplane is of great utility, and no one will contest its value for military purposes in view of the work it is doing in Tripoli, where it has, on more than one occasion, been of marked value to the Italians. But the aeroplane does not yet satisfy military requirements. It must carry at least one observer in addition to the pilot; it must be able to resume its flight unaided on any ground where it may happen to alight; and it must be absolutely reliable. The conditions imposed by the French military authorities are very severe, but this has not debarred makers from doing their best to satisfy them. The machines at Rheims are nearly all fitted with engines of 100 to 140 horse-power. There are monoplanes and biplanes and triplanes, and a machine with four engines which can be run separately or simultaneously for varying the speed. There has been a good deal of controversy as to whether the monoplane or multiplane is preferable for military work, but no light has been thrown on this matter at Rheims, for the reason that up to the present it has been impossible, on account of the weather, to carry out the programme. Two or three men have been killed during the experiments, but, on the other hand, Vidart has done some surprising work with a monoplane when caught at a fairly high altitude in a storm. So far as they have gone the trials of these powerful machines under favorable weather conditions have not given altogether encouraging results. Meanwhile, the Wright brothers claim that they are in a fair way to perfecting a machine which will hover in a breeze and will only need an engine of small power. It is by experiments like these that we may hope to see the design of aeroplanes saved from the rut into which it appears to be descending.—*The Engineer*, November 3, 1911.

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NAVAL AVIATION

Ensign Conneau of the French Navy has, in quick succession, performed three brilliant feats in aviation, giving, in the Paris-Rome flight, the European circuit, and the English tour, proofs of a daring, endurance, and science out of the common. An operator of such ability naturally entertains ideas, —the more interesting to know from the fact that, in the matter of marine aviation, we are still groping in the dark. Mr. Conneau thinks that the present aeroplane, in spite of its defects, can be made use of with great advantage. At once the question is raised, "How is it to be utilised? Can it be relied upon sufficiently to render serious service?" "Certainly," answers Mr. Conneau, who would like to divide aeroplanes into two classes, just as torpedo boats are divided: The land ones to operate along the coasts and at short

distances out to sea, and the sea-going ones to be attached to ships. The first would make flights of fifty kilometers, at a maximum height of fifteen meters, in order to study the horizon and discover the adversary, his formation, the course he is steering, his probable intentions, the lines of mines he may have laid, and, finally, the submarines he has placed in observation off the harbor.

In regard to the sea-going aeroplane, that could be placed on the deck of an auxiliary cruiser, as being unencumbered by the impedimenta of a man-of-war. From the cruiser, the aeroplane would sail away to reconnoitre, rising spirally in the air to inspect the horizon in a circle one hundred miles in diameter. After gathering all the desired information, it would return to the ship, which would communicate, by wireless, to the squadron to which it is attached, the information obtained. In that way the ocean aeroplane would be made the efficient collaborator of the wireless telegraph. In any case, the aeroplane would remain in the vicinity of its convoy, so as to be fished up in case of mishap, which is always possible under the circumstances. Of course such a role does not appear a very pretentious one, but our apparatus is still far from perfection, and the special problem of its safety is not yet solved. We must not demand too much of it for the present; it will be time enough to increase the radius of action as improvements are made.

Reference has been made to height. That factor, it has just been demonstrated, has attained a maximum, which aviators are endeavoring to exceed. The diagrams of the apparatuses of the machines that competed for height all show a decrease in the ascending speed between 1000 and 2000 meters. Above 2000 meters speed decreases rapidly, and, according to Captain Felix, who holds in France the record for height, the oxygen fails in the gasoline motor at a height of 3500 meters. Thus the rarefaction of air becomes an important problem in aviation. In order to remedy that inconvenience, several means have been proposed, of which one, advocated by Mr. Marcel Hanriot, of the Academy of Sciences, consists in using liquid oxygen to furnish the carbureter with the necessary "carburant," whatever may be the barometric pressure. It is calculated that a liter of liquid oxygen will produce about 1000 liters of gas under a weight of 1200 grams, which would mean an extra charge of 2.5 K.

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—*The Navy*, September, 1911.

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NAVAL HYDROAEROPLANE EXPERIMENT

(Launching from a wire cable.)

A successful experiment of great importance to the aeronautical department of the Navy was carried out at the Curtiss factory and experimental grounds at Hammondsport, N. Y., Sept. 7.

This was the launching of the Navy's new Curtiss hydro-aeroplane from a wire cable stretched from a platform erected 150 feet from the shore of Lake Keuka to the water.

The experiment was organized and directed successfully by Lieut. T. G. Ellyson, of the Navy, who was the first member of that branch of the military service to become a qualified aviator.

The object of this unique method of launching an aeroplane was, as stated by Lieut. Ellyson, to produce further evidence of the practicability of the hydro-aeroplane for use on vessels of navies.

By Lieut. Ellyson's methods a hydro-aeroplane may be launched at sea under any conditions, without the loss of time in putting it overboard to arise from the water and without delay because of rough sea. Under the new method it will only be necessary to stretch a wire cable from the boat deck of a battleship to the bow, down which incline the hydro-aeroplane can slide. It is maintained in balance on the main cable by two auxiliary wires, one stretched on either side, parallel to the central cable. These two auxiliary wires support the right and left wings until the machine gets up sufficient headway to maintain its own balance by means of its balancing planes.

The rigging for launching the hydro-aeroplane does not interfere in any way with the armament of the ship. It will not be necessary even to remove this rigging. It can be left standing for immediate use, or it can be taken down and stowed away in a few minutes.

This system enables the machine to be launched when a high sea would make it impossible to arise directly from the surface of the water after being lowered over the side of the ship. Previous experiments carried out at San Diego, California, last winter in connection with the U. S. S. *Pennsylvania* showed that the hydro-aeroplane could be landed alongside and hoisted aboard ship in a wind of 10 knots and when a 4-knot tide was running with sea conditions too rough for successful launching. Lieut. Ellyson regarded the getting away from the ship as being by far the most important point in the practical use of the aeroplane in the navy, since the loss of the machine after the desired information had been secured would be of minor importance.

With the new method it is also possible for the ship to steam ahead into the wind at any desired speed, and thus readily secure the necessary condition of wind for quick launching.

The machine used by Lieut. Ellyson was the regular type of two-passenger navy hydro-aeroplane, built by Curtiss, with 75 h.p. engine, fitted with a double control system, so that the operation of the machine can be shifted from one occupant to the other while in the air. The total weight is 1,200 pounds.

The hydro-aeroplane was launched from a platform and rose from the wire cable in 150 feet, after attaining a speed of 30 miles against a wind of about 10 miles. The launching apparatus is very simple, consisting merely of a wire cable 250 feet long and $\frac{3}{4}$ of an inch in diameter, which was made fast to a pile 75 feet from shore driven down in the water far enough to allow the hydro-aeroplane to pass over it. The wire cable passes over a pair of shears 16 feet high, fitted with a platform upon which to stand when starting the motor. The bottom of the pontoon under the hydro-aeroplane is fitted with a groove one inch wide and $1\frac{3}{4}$ inches deep, lined at the ends with tin and reinforced at the bow and stern with band iron to protect the bearing surface. Each wing is fitted with a light iron, forming a bearing surface to engage the balancing wires strung on each side of the main supporting cable.

The grade was about 10 per cent. The wind blew about 10 miles an hour, slightly quartering against the line of flight. The machine was first floated in the lake and then pulled up on the cable.

The releasing device consists of a short piece of rope fast to the bow of the pontoon and fitted with an eye through which passes a toggle pin connecting this short piece with a rope made fast to the legs of the shears. By a sharp pull on this toggle pin the hydro-aeroplane is released and quickly gathers headway under the impulse from the motor and the slight angle at at which the cable is placed. Two men held small lines running to each wing to make sure that the machine would keep its balance until full headway had been gained, but their assistance was not required. Lieut. Ellyson and Lieut. J. H. Towers, who are in charge of the Government work at Hammondsport, N. Y., have been practising since the first of May with the hydro-aeroplane, flying out over the lake nearly every day, in order to become thoroughly accustomed to the machine and to be able to handle it under all possible conditions. The Navy's hydro-aeroplane has been taken to Annapolis, Md., where the Navy training school has been established, and it is hoped to try the method of launching it from an aerial cable on board a battleship this fall.—*Aeronautics*, October, 1911.

Short Notes

Torpedo Patrols for Coast Defenses.—The creation of a seventh flotilla of torpedo boat destroyers, to be stationed along that part of our coast most open to attack from the power which we are all asked to believe must some day come to death grips with us on the sea, is a sign that the authorities have not yet fully developed that adequate scheme of coast patrol and protection, which was planned as long ago as 1904. As vessels become available we receive evidence of what this plan is likely to be when complete, and there is certainly no sign that the so-called "weak spot" has been overlooked. In fact every increased atom of torpedo craft protection has been piled along our Eastern and N.-Eastern shores, until we are assuredly now in such a position of defense along this line of "certain attack", that even the most nervous of old ladies who live in that part of the country, should sleep o'nights, without any fear of harm befalling either their persons or their property. From Scapa Flow to Falmouth the series of interlocking, and even over-lapping, destroyer and torpedo boat patrols is now continuous and ample, and each Commander of the separate flotillas knows every inch of the water he is responsible for, without any of those dire happenings having occurred which we have so often been threatened with by half-informed critics. And behind the offing patrol we have an inshore defense of submarine craft, not yet complete in numbers to crinoline these islands, but numerous enough to meet all likely contingencies in the present state of the fleets of our rivals. Our motto in future, as in the past, need only be "watch and work."

—*United Service Gazette*, December 7, 1911.

Loading Apparatus for Heavy Guns.—One of the points which have been closely watched by the gunnery experts of the fleet, but of which no accurate account has yet been, nor is likely to be given, in connection with the *Orion's* gunnery trials, is the rapidity of fire attained by the new 13.5-inch guns. An increase in the caliber and size of the gun naturally tends, in the ordinary way, to reduce the rate of fire, although this is not so marked as it was in the

old hand-loading guns, or even in the hand-loading guns of today, now that there are hydraulic and electrical machines for performing all the loading operations at heavy guns. "Power" machines can be made to move a 1,250 pound projectile, with its cordite gun-charge, almost as rapidly as it moves an 850 pound shell, and its accompanying charge, in bringing them up from the shell-rooms and magazines, and placing them in the breech of the gun. The system of ammunition supply remains much the same in the 13.5-inch ships as in the 12-inch, and is ahead of the systems used by most foreign nations; so much so that the Americans copied our plan a year or two back, after having an accident that might have proved much more disastrous than it did, through there being direct communication between the inside of their turrets on top and the magazines and shell rooms below. The British system has a break in the supply, but not one that at all delays—but rather facilitates—loading operations. It is expected that this system will prove as efficient in the 13.5-inch *Orion* as in her 12-inch predecessors, but no public report has been made on this point.

—*United Service Gazette*, November 9, 1911.

Guns, Armor and Projectiles.—As we have often pointed out in these columns, the race between the gunmakers, armor-makers and the projectile manufacturers, for naval purposes, is both intense and eternal. Recently it has looked as if the gunmakers were many laps ahead and had beaten their opponents hands down. But fortune varies in this as in all things, and today the armor-makers come up smiling and declare they can, by a very simple method, effectively meet the combined skill of the gun and projectile makers, and still protect the vitals and the turrets of our capital ships against the worst effect of their joint attack. This method consists in placing thin steel armor plates, of not more than one inch in thickness, some distance in front of the heavy plates that clothe the gun-positions and vital parts of the vessels to be protected. The function of the "skin-plates" is to break off the soft noses, or penetrating caps, which are at present used as projectiles, and which give these projectiles such large penetrative powers. It is claimed that, thus decapitated, the projectiles attack the thick armor plates behind the skin-plates with a greatly depreciated power, which renders the heavier plates immune from serious damage; and if this claim is substantiated the armor-makers have indeed once more called check, although it is not checkmate, to their enterprising and energetic opponents. The experiments with this system of protection is being carried out by our American cousins at their Indian Head establishment, and is spoken of hopefully by those whose judgment carries weight in such matters.

—*United Service Gazette*, December 28, 1911.

Characteristics of Modern Battleships.—The British model is still being largely copied by the battleship-builders of foreign nations, so far as outline of hull is concerned; although there is considerable difference in the way the mast and superstructure is dealt with by the designers of the world's warships. No doubt we shall presently begin to return to smaller targets, and eventually go on to the submersible battleship and cruiser, but at present the tendency is towards big targets as well as large dimensions—not that the one is necessarily a concomitant of the other. It is the super-posed turrets that are making modern battleships such huge targets for their opponents

to fire at. The super-posed turret is, of course, necessary to the middle-line concentration of fire and gives the guns in the upper turret a splendid position of command. But at the same time they are a mark which could not be easily missed by well-trained gunners. Bridges and fore and aft structures are being kept down to the minimum in the latest Capital ships, but huge groups of ventilators and smokestacks of large dimensions are still a feature with some nations, and more especially with the Germans. Tripod masts are not yet in favor in the Kaiser's fleet, though they are being largely adopted in America and in this country. Torpedo nets are being more generally fitted by foreign navies than they were, and armored protection is being given to the anti-torpedo armament; while a secondary armament appears to be growing in favor abroad, but is still eschewed by the British Admiralty—*United Service Gazette*, November 16, 1911.

The Orion's Gunnery Trials.—As we anticipated in these columns a few weeks back, when dealing with the increasing size of the primary guns of the Navy, and the consequent enlargement of the already powerful charges which are used to propel their projectiles, one of the most crucial tests in the gunnery trials of the new battleship *Orion*, with her 13.5-inch armament, was that of the "blast test." The ship appears to have emerged from this test with no more damage to her hull and the fittings surrounding the muzzles of the large guns, in their arc of fire, than could have been expected, considering she is the first ship of her type to be armed with the 13.5-inch gun of modern pattern. The charges of the old 13.5 weapon were much less powerful and the blast, therefore, much less destructive, than the 12-inch guns that succeeded them; but it was necessary in both cases, in the earlier type of battleship, to fit what is known as a "flash plate" across the sweep of deck over which the muzzles of the guns passed from any point at which they could be fired, in travelling from one broadside to the other. At the *Orion* trials the bottom of a boat was blown out by the blast, but that is not at all exceptional in a new ship firing her guns for the first time; indeed it is by such experience, showing which line the released gases are likely to take, that the ill-effects of the blast can be reduced to a minimum. Taken altogether, the authorities appear to have largely anticipated the safeguards which would be required, and have successfully placed them in position.

—*United Service Gazette*, October 19, 1911.

New Armor Plate.—A German engineer is reported to have invented a new kind of armor plate which has just been tested by the naval authorities and reported upon favorably. The peculiarity of the armor is its extreme lightness, while it has been proved, it is said, to be of equal, if not greater, resisting power. The armor is made up of a special aluminum alloy faced by a thin hardened steel plate. Gun shields made from it have been definitely ordered for the new cruiser *Strasburg*. It is at present considered doubtful whether the new system of armor is applicable to the belt armor of battleships, but it is expected to be extremely useful for armor-belting small vessels.

—*The Engineer*, November 3, 1911.

Submarine Mines for Naval Work.—Gradually the Navy is abandoning all submarine mining operations, so far as ship-work is concerned. It has only been by a very slow process that the large mines formerly carried in the

mining-rooms of battleships and large cruisers, have been jettisoned in favor of some much more useful material for sea purposes. The principal lever used by those who sought to prise observation and countermines out of sea-going ships was the fact that a new system of coast defense had been established, in which torpedo craft patrols played a large part, as well as the change which placed all mining work near Naval bases around the United Kingdom in the hands of Naval men. This latter change called the mine-layer into "being" with its load of blockade mines and great facilities for running them, and which are, for the most part, useful old second-class cruisers, converted to this use, and given prolonged lives on the active service list. With the advent of this latter class of vessel, all those who had previously refused to be a party to removing mines from battleships and cruisers, felt the time had come to waive their objections, and so mining work in the Navy has now become almost a distinct department. So much is this the case that Naval coopers, who used to be put through a mining course in the torpedo schools, are no longer sent to these establishments for instruction, as the old wooden, or mechanical, mine has now entirely disappeared. and iron mines of the blockade pattern have taken their place. The coast defense system of Naval mining is stated by experts to be very complete and efficient, and a complete safeguard to our Naval and mercantile ports.

—*United Service Gazette*, October 19, 1911.

Printing Without Printing Ink.—This invention is the product of an English inventor. In the course of some electrical experiments he accidentally pressed a coin, which had fallen on to the table and was rolling off, against a metallic plate covered with a piece of paper, and at the same time against an insulated electric line. To his amazement he saw a sepia print of the coin impressed upon the paper. This happened about twelve years ago. Since then the inventor has followed up this observation, and has now developed a process for printing without printing ink. He uses dry paper impregnated with certain chemicals, whose nature is not disclosed. In the process of printing the paper travels over a metal plate and the type is applied on the opposite side, a current of electricity passing through the paper. According to the particular metal used for the sub-stratum, and according to the mode of impregnation of the paper, a great variety of different colors can be produced, so that multi-color printing becomes an easy matter.

—*Die Welt der Technik* in the *Scientific American Sup.*, December 30, 1911.

Wireless Spans the Pacific.—For the first time in the history of wireless transmission communication was established October 5 between the San Francisco operator at Hill Crest and the Hokushu station, Japan, 6000 miles distant. Hokushu is the most northern wireless station of Japan.

—*Electrical World*, October 21, 1911.

NOTICES

NINTH INTERNATIONAL RED CROSS CONFERENCE

The American Red Cross desires again to invite attention to the exhibition in connection with the Ninth International Red Cross Conference, which will be held in Washington, D. C., from May 7 to 17, 1912.

The exhibition will be divided into two sections, which will be styled Marie Feodorovna and General. The former is a prize competition, with prizes aggregating 18,000 rubles, or approximately $9,000, divided into nine prizes, one of 6,000 rubles, approximately $3,000; two of 3,000 rubles each, and six of 1,000 rubles each.

The subjects of this competition are as follows:

1. A scheme for the removal of wounded from the battlefield with the minimum number of stretcher bearers.
2. Portable (surgeons') washstands, for use in the field.
3. The best method of packing dressings for use at first aid and dressing stations.
4. Wheeled stretchers.
5. Transport of stretchers on mule back.
6. Easily folding portable stretchers.
7. Transport of the wounded between warships and hospital ships, and the coast.
8. The best method of heating railway cars by a system independent of steam from the locomotive.
9. The best model of portable Roentgen apparatus, permitting utilization of X-rays on the battlefield and at first aid stations.

The maximum prize will be awarded to the best exhibit, irrespective of the subject, and so on.

The General Exhibit is again divided into two parts; the first will be an exhibition by the various Red Cross Associations of the world. The second will be devoted to exhibits by individuals or business houses of any articles having to do with the amelioration of the sufferings of sick and wounded in war, which are not covered by the Marie Feodorovna Prize Competition for the year. While the American Red Cross will be glad to have any articles pertaining to medical and surgical practice in the field, it is especially anxious to secure a full exhibit relating to preventive measures in campaign. Such articles will be classified as follows:

1. Apparatus for furnishing good water in the field.
2. Field apparatus for the disposal of wastes.
3. Shelter such as portable huts, tents and the like, for hospital purposes.
4. Transport apparatus (to prevent the suffering of sick and wounded) exclusive of such apparatus as specified for the Marie Feodorovna Prize Competition.

As with the Marie Feodorovna Prize Competition, for this country only articles having the approval of the Central Committee of the American Red Cross will be accepted.

Diplomas will be awarded for exhibits in this section of the exhibition as approved and recommended by the Jury.

Further information may be obtained from the Chairman, Exhibition Committee, American Red Cross, Washington, D. C.

It is perhaps to apparatus having to do with prevention of disease in armies that the energies of Americans have been especially directed since the Spanish-American War. Therefore, the last mentioned section of the Exhibition should make an appeal to them.

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BUREAU OF MINES' PUBLICATIONS FOR FREE DISTRIBUTION

We have been asked to print the following notice:

DEPARTMENT OF THE INTERIOR

BUREAU OF MINES

New Publications. (List 7.—December, 1911.)

Bulletins.

Bulletin 6. Coals available for the manufacture of illuminating gas, by A. H. White and Perry Barker. 1911. 77 pp. 4 pls.

Bulletin 16. The uses of peat for fuel and other purposes, by Charles A Davis. 1911. 214 pp. 1 pl.

Bulletin 19. Physical and chemical properties of the petroleums of the San Joaquin Valley, California, by I. C. Allen and W. A. Jacobs, with a chapter on analyses of natural gas from the southern California oil fields, by G. A. Burrell. 1911. 60 pp. 2 pls.

Reprints.

Bulletin 21. The significance of drafts in steam-boiler practice, by W. T. Ray and Henry Kreisinger. 62 pp. Reprint of United States Geological Survey Bulletin 367. Copies will not be sent to persons who received Bulletin 367.

Bulletin 26. Notes on explosive mine gases and dusts, by R. T. Chamberlin. 67 pp. Reprint of United States Geological Survey Bulletin 383. Copies will not be sent to persons who received Bulletin 383.

Bulletin 29. The effect of oxygen in coal, by David White. 80 pp. 3 pls. Reprint of United States Geological Survey Bulletin 382. Copies will not be sent to persons who received Bulletin 382.

Bulletin 30. Briquetting tests at the fuel-testing plant, Norfolk, Va., 1907-8, by C. L. Wright. 41 pp. 9 pls. Reprint of United States Geological Survey Bulletin 385. Copies will not be sent to persons who received Bulletin 385.

The Bureau of Mines has copies of these publications for free distribution, but can not give more than one copy of the same bulletin to one person. Requests for all papers can not be granted without satisfactory reason. In asking for publications please order them by number and title. Applications should be addressed to the Director of the Bureau of Mines, Washington, D. C.

"THE ELECTRICIAN" ELECTRICAL TRADE'S DIRECTORY AND HANDBOOK

"The Electrician" (London) announces the 1912 edition of their Electrical Trade's Directory and Handbook, being its 29th year. It contains addresses of firms in electrical trades in all parts of the world, the laws of various countries touching these trades, Lloyd's Register Rules for the use of light on board vessels, submarine cable data, and data pertaining to wireless telegraphy and telephony. These are but few of the items in the summary of contents. The price is 15s., postage extra, (in the U.S. 3/6).

NATIONAL AERONAUTICAL EXPOSITION

It is proposed to hold a National Aeronautical Exposition in New York City, May 9th to 18th, 1912. It will be representative of the present and future of the industry. Particulars will be published later.

CORRESPONDENCE

Any communication received by the Editor, which the writer desires inserted, which is signed by him and which would be of interest to the readers of the JOURNAL from a military point of view, will be published in this department. It is especially desired to have questions asked and small items of information given. Questions asked in one issue will be answered in the next, where possible, by some person, or persons, who is considered to be capable of giving authoritative information on the subject involved. Answers or remarks, regarding any such question by any others will always be very welcome. The readers of the JOURNAL (and all others interested in it or its work) are most cordially invited to make full use of this department.

PHOTOGRAPHING GUNS IN ACTION*

By Captain FRANCIS J. BEHR, Coast Artillery Corps

Director, Department of Enlisted Specialists, Coast Artillery School

Photography is one of the subjects taught in the Artillery Course of the Department of Enlisted Specialists. While the instruction is more, or less, elementary in character, the primary object being the training of the men to take the photographs of the splashes at target practice for the purpose of determining the longitudinal deviations, the scope is gradually being extended to include subjects which may be required to be photographed at any post. This includes copying, enlarging, making prints for lantern slides; and likewise making use of photography as an adjunct to drawing, where black and white perspective of an object may be desirable.

Having available at this department, lens, shutter, and plate for comparatively high speed photography, the problem of representing the phenomena of the motion of the projectile from the instant it starts until it has passed out of the field of the camera's view, became a fascinating one, from the standpoint of photography itself as well as Artillery. While the results so far accomplished, shown in the illustrations of the November-December, 1911, issue of the JOURNAL, is but the beginning of what it is hoped to obtain in this line, it was thought best to attempt the solution at the muzzle of the gun, since the greatest difficulties would be encountered at this step.

As reliable results, which can be duplicated if desired, are requisite in working at a problem of this nature, it is evident to the most casual observer, that some device other than the hand was necessary to actuate the system positively at the instant required to produce the results sought. The time factor is entirely too small for the hand to have anything to do with causing the system to function—unless chance is relied on for results.

The first difficulty encountered was the blast effect of the 12-inch gun at the instant of discharge on the camera itself, as it had to be placed close enough to obtain all details. The next step was to devise an electrical system, diagrammatically indicated in Fig. 1, by means of which the camera could be actuated—but without in any way interfering with the target practice. The device was first attached to the carriage so that at the first movement of the gun in recoiling, it would cause the camera to function. Through a micrometer screw, the setting could be varied to any distance, within limits, desired.

* See illustrations, "Twelve-inch Guns in Action", following page 272, Journal for November-December, 1911.

Due to the variable movement of recoil and the elasticity of the part of the carriage to which attached, it was readily discovered that no uniform results could be anticipated from this method. The device was then modified

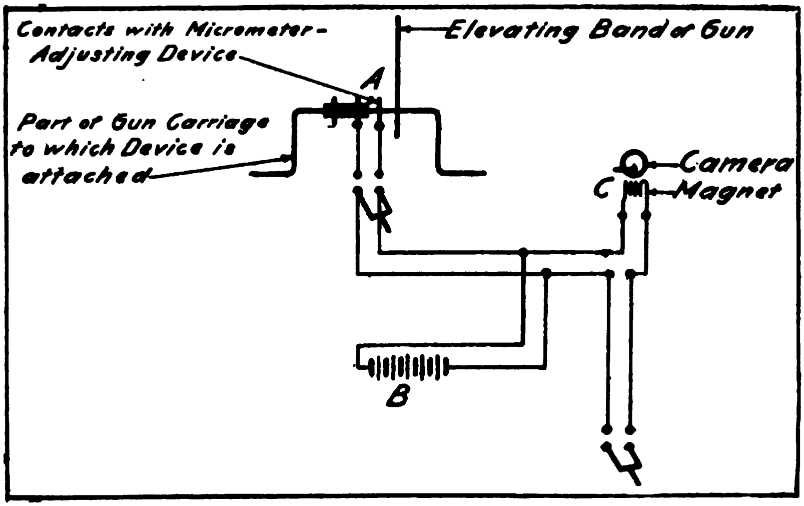

FIG. 1.

so that the projectile itself actuated the electrical system, indicated diagrammatically in Fig. 2, thus eliminating the variable movement of recoil, as well as the elasticity of the carriage, and leaving but the consideration of the time factor required to arm the magnet—which by laboratory test was found

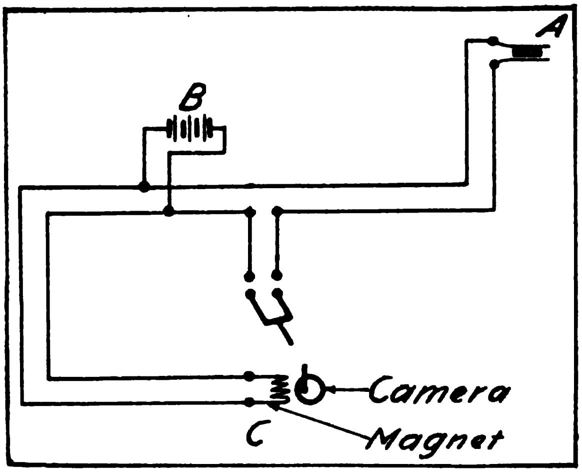

FIG. 2.

to be $\frac{1}{80}$ second, agreeing closely with the distance travelled by the projectile in photograph showing same. Several photographs have been taken with the latter device with the same setting, which show practically the same results, thus giving assurance of uniformity.

BOOK REVIEWS

My Experiences at Nan Shan and Port Arthur with the Fifth East Siberian Rifles. By Lieut.-General N. A. Tretyakov. Translated by Lieutenant A. C. Alford, R. A. Edited by Captain F. Nolan Baker, R. A. London: Hugh Rees, Ltd., 119 Pall Mall, S. W. 16 + 312 pp. 32 il. 2 plates. 6 maps. 8¾" x 5½". 1911. Price, 12/6 net.

One finishes reading this book with a vivid sense of the actualities of modern warfare, especially of the fierceness of the struggle around and about Port Arthur and of the desperate gallantry displayed by both the Russian and Japanese soldiers. Indeed, General Tretyakov's experiences give the actual history of the fighting line. We follow the fortunes of his own unit, we live with his men amidst the blood-stained wreck of their trenches on 203-Metre Hill, losing all thought of the general conduct of the attack and defense of the fortress,—in a word, we are transported from the dry bones of military history to the living realities of the battlefield.

The writer—Lieutenant General (then Colonel) Tretyakov—was commander of the Western Section of the Defenses and took a prominent and gallant part in the historic defense of Port Arthur. In 1909, in a series of articles, he placed before his countrymen the record of his experiences at Nan Shan and within the beleaguered fortress. In the present volume we have the English translation of his narrative. As the editor states: "No more touching and direct appeal to judge its beaten heroes sympathetically and fairly has ever been made to a nation." It is a plane tale, a fitting record of soldierly devotion. As such it is offered to English readers.

Beginning with the arrival of the 5th Regiment at Chin-chou in 1903, the author gives in graphic sentences the condition of affairs on the eve of declaration of war; the calm sense of security the Russians felt in the invulnerability of their fleet, and the rude awakening caused by the first Japanese torpedo attack on the Russian ships at Port Arthur. "This news was a great shock to me. * * Now began a period of activity such as I had never before experienced in the whole of my service. We fortified the positions, brought up stores, instructed the recruits and reservists, of whom more than half of the regiment was now composed, and, lastly, kept a look-out for the enemy, for which latter duty two hundred men were required daily." The work of restoring the fortifications of the Nan Shan position, the preliminary engagements with the enemy, and finally the battle of Nan Shan, are described in interesting detail. It is plainly apparent that the Russian soldier—both officers and men—are willing and brave under most adverse conditions. Leadership was lacking; there was no co-ordination of purpose; no cohesion. "There cannot be two commanders in one part of a field of battle, and we had three—General Fock, General Nadyein, and myself."

Then follows the retreat to Port Arthur, the occupation and fortification of the successive positions taken up by the Russians, and the final retirement to the hills about Port Arthur. The description of the regiment's incessant activities is full of interest. In intimate language we have the daily life of the soldier in campaign,—the hardships borne and the wonderful amount of of work accomplished.

The climax is reached in the author's account of the incessant assaults on the hills around Port Arthur, which vividly portrays the fierceness of fighting on both sides as they successively fell into the hands of the enemy, the stubborn and valiant defense of the besieged, and the desperate hand-to-hand struggles in the final stand in the trenches on 203-Metre Hill. The main facts of the siege of this fortress are history now, but nowhere else have we seen the human element—the soldier's feelings, passions, his devotion to duty, so strikingly yet unassumingly presented.

Throughout the book one meets with the reflections of the trained soldier. It affords, also, example after example, interesting and instructive, of military cause and effect. The author rarely criticises. Of cheerful and unassuming character and great self-restraint in the midst of adversity, he shows us every one cheerfully doing his best to make bricks without straw.

The book is illustrated by a number of photographs of officers of the regiment, of views of the principal hills around Port Arthur and others showing places where the events described took place. Six good maps assist one in following the text.

✦ ✦ ✦

The Autobiography of John Fritz. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. $6\frac{3}{4}'' \times 9\frac{1}{2}''$. vi + 327 pp. 21 il. Cloth. 1912. Price, $2.00.

The life-story, told in simple homely phrase, of that widely known and well-beloved pioneer of the iron and steel industry in America, "Uncle John Fritz."

As the author modestly puts it in his half-page preface, the reader "must not expect fine language nor eloquent periods, but only the honest record of the hard-working life of one who loves his country and his fellow men and who has tried to serve both."

And what a record of conscientious service and real accomplishment it is! What an inspiration to like effort is here found for each of the hundreds of young technical engineers now graduating from our special schools, colleges, and universities.

During the sixty years of his active business career John Fritz was personally identified with each progressive step in the development of our iron and steel industries. His great creative work in the upbuilding of the Cambria Iron Company at Johnstown, Penna., and of the Bethlehem Iron and Steel Company at South Bethlehem, Penna., entitles him to high rank among the world's most successful mechanical engineers. It is to him, more than to any other man, that the War and Navy Departments are indebted for their ability to procure the guns and armor needed for our coast defenses and battleships.

This autobiography should find a place in each post and school library, as it will certainly find place in every engineering library the world over.

The History of the Tenth Foot (The Lincolnshire Regiment), by Albert Lee, Author of "England's Sea Story", "Famous British Admirals", etc. Published for the Regimental Committee by Gale & Polden, Limited, Wellington Works, Aldershot, 1911, in Two Volumes, with numerous portraits of the Colonels and other illustrations; also an Alphabetical List of the Officers of the Regiment from 1685 to 1910, with dates of Commissions, War Services, etc. 5½" x 8¾". Vol. 1: x + 438 pp., 18 il. Vol. 2: vi + 444 pp., 23 il. 1911. Cloth. Price, 25 s per set.

The Army had "brought a king to justice and to the block, had given laws to England and held even Cromwell in awe," hence a condition imposed in the restoration of the Second Charles was its disbandment and with its dispersion was to end for all time the regime of militarism in England. Vain hope! The Fifth Monarchy men became active and even Parliament was forced to concede the necessity of maintaining a fighting force which should act in an emergency as a military police. By 1684 Charles had secured an army as strong in numbers as was that of the United States previous to the Civil War. Throughout the short and inglorious reign of James the Second the army question was a matter of contention but with the coming of James, Duke of Monmouth, in 1685, a force of fighting men adequate to the task of stamping out a dangerous rebellion was required. Monmouth was attainted of high treason, a reward of £5,000 was offered for his capture and £400,000 was voted to enable the King to cope with "the present extraordinary occasions." With the aid of this latter sum James levied several troops of horse, which afterwards formed the Corps called the Queen Dowager's Horse, now the Sixth Dragoon Guards, two regiments of Dragoons, now the King's Own Hussars, the Fourth Hussars and nine regiments of infantry. Among these infantry regiments was one destined to obtain a splendid record, and this was the Tenth or North Lincolnshire Regiment of Foot, now the Lincolnshire Regiment.

With such a beginning and with a continuous existence of much over two centuries it will be seen that "The History of the Tenth Foot" must virtually present a history of the British Army itself, and thus to the general reader such history possesses a larger interest than do so many of the periodically appearing chronicles of separate military organizations. In most attractive and entertaining form it preserves in detail a full record of the services of the famous Tenth from its first raising as "John, Earl of Bath's," in 1865, down to the present time.

No dearth of material confronts the historian of an organization that bears as honors upon its colors, "The Sphinx, superscribed 'Egypt' (1801 and 1898), Blenheim, Ramillies, Oudenarde, Malplaquet, Peninsula, Sobraon, Punjaub, Mooltan, Goojerat, Lucknow, Atbara, Khartoum, South Africa (1900-02) and Paardeburg. The research and labor involved in the task of collecting and recording the interesting and valuable information, much of it heretofore practically inaccessible, in the period between June 18, 1908, and the date of publication in 1911, must have been stupendous. A measure of the success of such efforts is found not only in the interest of the narrative itself, but also in the fact that sufficient remains in preparation to promise a third volume at a no distant day.

The work records much detail of organization, equipment and dress that casts valuable light upon the development of the modern fighting man. The pikeman, armed with his formidable flat headed spear with shaft of from 13 to 18 feet, was soon to disappear from the regiment after its formation,

the pike being replaced by the bayonet, which had been invented in 1640 and which was received first in England by the Foot Guards in 1686, a year after the formation of the Tenth. The grenadiers were first established in 1678, the tallest and finest men of the regiment being selected for this duty as they might reasonably be expected to throw further the missile from which they derived their name. That they might the more readily sling and unsling their muskets to permit the free handling of the grenade, the broad rimmed black beaver hat of the regimental uniform was replaced by a tall cap of the color of the facings. The musketeers were provided with the cumbersome matchlock which, however, was soon to give place to the flintlock. From the earlier weapon with its rapidity of fire of but a few shots per hour it is a far cry to the modern magazine and automatic arm.

The picturesque appearance of the soldier of the 17th century is well set forth in the description of the first regimental uniform, with its long full skirted blue coat lined with red which was exposed by turning cuffs, lapels and skirts, the full red knickerbockers and stockings, and the black hats with red bands and white lace trimmings. This brilliance was, however, entirely external for the life of the soldier of the period was somber enough and far from a happy one. The private was supposed to draw 8-d. per day and 6-d. of this was set apart for subsistence, the 2-d. difference being termed "gross off earnings" which was set aside for clothing, less a small percentage to the Paymaster General. As the 6-d. subsistence money must furnish quarters, fuel, light and provisions, no barracks being provided, one wonders how the men contrived to exist, though the greater purchasing power of a sixpence in those days must be considered. In view of its meagerness, no reduction of the clothing allowance in the interest of economy seems possible, for the enlisted man of the Tenth received:

"For the first year: A good coat well lined which may serve for the waistcoat the second year; a pair of good thick kersey breeches; a pair of good strong stockings; a pair of good strong shoes; a good shirt and neckcloth; a good hat well laced." The recruit received in addition, a new waistcoat and one shirt and one neckcloth more than the old soldier, who was supposed to have some linen on hand. "For the second year: A good cloth coat well lined, as for the first year; a waistcoat made of the former year's coat; a pair of strong kersey new breeches; a pair of good strong stockings; a pair of good strong shoes; a good shirt and neckcloth; a good hat well laced." Evidently on taking the field little remained for the Tenth to stow in the surplus kits of that day.

Even for that day it was evidently considered that the soldier's life had little to offer and there is no reason to doubt the truth of the remark of Edward Russell, who went to the Hague to urge the Prince of Orange to vindicate English liberties and the Protestant religion, that King James' soldiers were "bad Englishmen and worse Christians." Evidently they were good Protestants for the Tenth, almost to a man, declared for the Prince of Orange. Not to be wondered at is the failure of the Tenth before Blenheim to secure recruits. "The Captain Plumes and Sergeant Kites with their drums and ribbons and strong ale were unable to fill the ranks of the army with the 'youth of England, all on fire' "; so a Statute was agreed upon for raising recruits by empowering justices of the peace and mayors, or other head officers of boroughs, "to raise and levy such able bodied men as have no lawful calling, or employment, or visible means for their maintenance and livelihood, to serve as sol-

diers." The story of the Tenth shows that "if such recruits were ready to plunder, they were also ready to fight" and these "tattered prodigals" elevated the reputation of the British arms and immortalized the name of Marlborough.

At the first encampment of the Tenth at Hounslow Heath in May, 1686, the King, however, complains that "there was an absence of soldierlike simplicity among the officers; the regiments vied with each other in the magnificence of their tents and accommodation and in the expense of the Officer's entertainments to their London friends."

When the peace of Ryswick was signed, the old cry of "No Standing Army" was again heard and many encouraged it on the plea that the army might readily be made an instrument of despotism by the Sovereign. "Reams of puerile and pedantic nonsense had been written to prove that the militia was amply sufficient for England's needs." It will be seen that this sophistry has no recommendation of novelty but has come to us down the years with its invitation to national humiliation through martial inefficiency or through success of the actual enemy.

In view of present day interests there is a familiar note in the following selections: Once in Jamaica in 1786 "the Tenth remained there nine years apparently forgotten by the Government except for some attention in the matter of uniform or things of like nature. * * * A regiment might starve or die off and no effort was made to remedy the mischief, but as for the smart appearance of the regiment or some petty detail of uniform, that counted greatly and could not be neglected."

Of especial attraction to the American reader is the recital of the part played by the Tenth in the American War for Independence when it formed a part of the small relieving force which was sent out from England instead of the adequate army demanded by General Gage and other officers in touch with the situation in the colonies. Gage wrote: "If force is to be used at length, it must be a considerable one for to begin with small numbers will only encourage resistance and not terrify." While it is probable that the Tenth participated in some of the earlier expeditions sent out by General Gage it was at Lexington that the Tenth under its Lieut.-Colonel, Smith, came under the first fire of the American forces and a man of this regiment falling at the first volley of the Colonists shed the first blood in action in the War of Independence. This narrator confirms the truth of other records that but for the timely arrival of Earl Percy, the Tenth, with the grenadiers of the army and the marines under Major Pitcairn, would have played no further part in the War. As it was the Tenth were among the first to discover that the Colonists were no mean foes, a belief which Bunker Hill soon made still more convincing.

Then followed Long Island and the Tenth entered New York among the first. White Plains and Fort Washington leads the Tenth up to embarkation, the Branywine and Philadelphia. Clinton evacuated that city to avoid being starved out, yet it was a formidable body of 17,000 men and 46 field pieces that crossed into New Jersey and went into camp. And here the Tenth's records show that New Jersey nobly sustained her reputation, for the historian recites how "the features of the men were swollen past recognition by mosquito bites." So, too, the conflicting claims of love and duty are recorded, for on this movement Clinton is said to have lost six hundred men by desertion who had contracted "various attachments" in Philadelphia. Such side touches are many and add immeasurably to the human interest of the work.

Shattered by their experiences in the colonies and after an absence from home of 48 years the Tenth in 1778 returned to England. What it had suffered can be partially realized from the following extract from the Monthly Return, dated January 1, 1779, at Doncaster where the regiment was then quartered: "Effective rank and file present and fit for duty on Command. recruiting and furlow, 39 men; wanted to complete the allowance and bring the regiment up to full strength, 901 men."

When the menace of France, the War with the Colonies and the enmity of Spain had placed England in a position of extreme peril, the Territorial System was adopted under War Department Warrant dated August 31, 1782, and the rally to the colors indicated that the sentiment of the people had been successfully appealed to. The Tenth was apportioned to North Lincoln, the 69th becoming the South Lincolnshire Regiment and not until April 11, 1881, was the Tenth entitled to its present designation.

As showing the conditions governing enlistments in England at the end of the 18th Century there is inserted a reproduction of an ancient recruiting bill of the Tenth Regiment. Its stirring sentences follow:

"A Year's Wages advanced,

OR

TWENTY GUINEAS

For a DAY'S Pay.

Lincolnshire HEROES having always been remarkable for zealously Supporting their KING & COUNTRY, they are now presented with a glorious and never returning Opportunity of distinguishing themselves in the

North Lincolnshire

REGIMENT OF FOOT,

Commanded by

MAJOR GENERAL THE HONBLE. HENRY EDWARD FOX,

Now stationed in the flourishing City of Lincoln.

Let all those who delight in the HONOURABLE PROFESSION of ARMS, and disdain the DRUDGERY OF SERVITUDE, repair without loss of TIME to

(and here came names of various officers to be found at certain places) where they may exchange their WHIPS and SMOCKS for LACED COATS and SILVERHILTED SWORDS.

SPIRITED LADS of SIZE, CHARACTER and QUALIFICATIONS may acquit themselves of all Women labouring with Child, and young Children, and enter into the direct Road to HONOUR and PREFERMENT.

Upwards of Forty Sergeants and Corporals are yet wanted to complete the Regiment.

N. B. RECRUITS who enlist their comrades, shall receive TWO GUINEAS REWARD.

GOD BLESS THE KING,

AND DAMN THE FRENCH.

BROOKS, PRINTER, LINCOLN.

The esprit de corps of the organization is shown by the history of the Old Comrades Association, established in 1903, which is incorporated in the work. This Association has in view the promotion of regimental spirit, the exercise of mutual aid and the benefitting of old soldiers of the Regiment who are deserving and in needy circumstances. It proves the reality of comradeship and clearly shows that both officers and men realize the fine traditions of the Old Tenth.

No more fitting dismissal is possible than a quotation of the words of Lord Napier of Magdala on the title page of Vol. II:

"The deeds of gallantry that this Regiment performed ought to be recorded in letters of gold, and engraved in the memory of all British Soldiers."

✦ ✦ ✦

The Principles of Sanitary Tactics. A hand-book on the use of Medical Department detachments and organizations in campaign. By Edward L. Munson, Major, Medical Corps, U. S. A. 5″ x 8″. 306 pp. 1 Chart and 11 maps in text; 2 large maps as inserts. Price, $1.75.

The author defines sanitary tactics as "those dispositions and methods of the sanitary service as will cause the bringing together of the wounded, the medical officer, and the appropriate sanitary supplies or establishment, with a minimum of discomfort and delay and with the least interference with military purposes." The aim of the book is to give general information concerning sanitary tactics as a whole and to assist in the standardization of instruction on the subject of which it treats. As the author states in his preface, there is undoubtedly a far too hazy impression in the minds of many officers of the line and of the Medical Department of the importance, scope, and methods of employment of the sanitary service with troops in campaign.

To the medical officer a knowledge of military methods is necessary to enable him to manage his own sanitary organization to the best advantage, and the study of tactics is required in order that he may interpret the significance of the battlefield drama and make his dispositions of the sanitary organizations to the best advantage. The sanitary service should co-ordinate, and after receiving general orders relating to it should be capable of administering itself and its units in a tactical sense, within itself and in relation to the other components of a military force, in thorough consonance with such general purpose. The duties of the Medical Department in time of peace unfortunately give little training for its function in war.

The method of instruction of the book is by means of problems which gradually lead the student through a consideration of the sanitary tactics relating to the smaller units and more or less isolated situations, toward a conception of the combined employment, under progressive military phases and conditions, of the combatant organizations and the sanitary detachments and units of an infantry division in war.

In conjunction with Lieutenant Colonel John F. Morrison, General Staff, the author published a year ago under the title "A Study in Troop Leading and Management of the Sanitary Service in War," a problem worked out in detail from both the tactical and sanitary aspects of an infantry division in combat. A review of this book appeared in the JOURNAL for December, 1910.

These two books, with Straub's "Medical Service in Campaign," present for the first time in English a comprehensive exposition of the principles which form the basis for the tactical use of the sanitary service in the field.

✦ ✦ ✦

The Relations of the United States and Spain. The Spanish-American War. By Rear-Admiral French Ensor Chadwick, U. S. Navy (retired). New York: Charles Scribner's Sons. 6½" x 9¼". Vol. 1, 412 pp. Vol. 2, 514 pp. 28 maps. 1911. Price, $7.00 per set.

This work concerning the war with Spain, is intended to be, as Admiral Chadwick, the author writes, a documentary history. It is also a supplementary and companion work to the volume entitled, "The Relations of the United States with Spain—Diplomacy" (reviewed in the JOURNAL for January-February, 1910) recently published by the same eminent writer, concerning a different phase of the same war. The subject is of necessity treated most comprehensively, but being written in the clear and delightful narrative style of the author, is not only highly interesting and readable, but is valuable because exact.

While it is not to be expected that these volumes will be able to speak the final word upon this important period of our country's history, yet they are so carefully compiled, and their author is gifted with such clearness of judgment, that for all time this work will be a most suggestive book of reference and upon many subjects will be a final court of appeal. Certainly no future writer concerning our relations with Spain will be fully equipped to deal with the Spanish question, unless these volumes of Admiral Chadwick's are included in his bibliography and are made an intimate portion of his knowledge.

The numerous charts and maps included in this work, particularly those detailing the positions of the American and Spanish fleets at Manila Bay and at Santiago Harbor, are most valuable. Together with these strategic maps there is also a most useful "table of distances", which when carefully studied reveals many surprises, especially in the oriental scenes of the Spanish-American struggle.

That most deplorable controversy between high-ranking commanders of the Navy is dealt with by the Admiral in a calm, dispassionate, convincing manner. He gives equal praise to the two gallant officers, whom the country will remember with gratitude for all time.

The chapter written concerning the forces engaged in the struggle, compiled as it is from authoritative sources, reveals much important data hitherto inaccessible, or so difficult to obtain as to thwart most students of history.

This work of Admiral Chadwick's clears up many popular delusions and misconceptions. The real reasons of the outburst of the war, its long delayed, but inevitable, arrival, the methods required by law in the appointment of Army and Navy officers to supreme command of armies and fleets, the reasons for the seemingly needless sacrifice of men, the glory of the attacks especially at San Juan and El Caney,—these are but a few illustrations of the oft-discussed questions elucidated and which tend to show the noble purpose actuating the compiling of the volumes.

As is perfectly natural, the Admiral, being an officer of the Navy, gives full credit to the bravery and ability, of the personnel of the fleets but he gives equal praise to the bravery of the troops. As a prelude to his own tribute to them at El Caney and San Juan, the author quotes Lieutenant Miley

—"Much," he writes, "has been written about them, but no description can convey to the reader a just appreciation of the gallantry and heroism displayed by officers and men alike." And then Admiral Chadwick continues in words worth remembering and quoting—"It was known to all that there were some 12,000 Spanish troops in and about Santiago. For all that our men knew, they were faced by nearly the whole of this very considerable army, greater by many thousands than the advance of the column which had so wearily crawled through the mud and brush into visibility. They had every reason to expect a great force rather than the few hundreds who fled the trenches as the Americans climbed the hills. It was, in fact, as gallant a deed in spirit as was ever done, and were America as fortunate as is another Anglo-Saxon country in turning her deeds to poetic account, the poet would find in this as fitting an episode for his gift as any of those which have been sung into lasting fame."

The capture of Manila is graphically described, from the day of the victory of Admiral Dewey to the occupation of the city after its capture by our troops. Here again credit is given not only to the Navy but also to the valor and gallantry of the Army. Such courteous touches of appreciation from such a gallant and clear-headed officer of the Navy, tend to bring the two branches of the service closer together.

In the concerns of war, the maxim, "a little knowledge is a dangerous thing," is doubly true, and one who takes the trouble to read Admiral Chadwick's volumes on the Spanish War will be far better fitted to decide for, or against, the grim necessity of war, than a citizen who complacently listens to unscientific reports and is swayed, through ignorance and inability, by the much haggled and misconstrued rumors of things that never existed in any nation's history.

In the appendix of the second volume of this work there will be found a carefully selected bibliography, giving the names of authors of works, both individual and governmental publications, and also collateral authorities, which to the student of American wars will prove invaluable.

There are times when Admiral Chadwick looking out upon the troubled seas of contemporary history from his bridge of advantageous experience, sees beyond the horizon of the ordinary writer. His words are worth recording, notably an utterance regarding our conquests in the Eastern Seas:—"The forces which impel national action, and which led us thither, lie in this case as in most, too deep for any real analysis. The actors who are supposed to guide are but unconscious instruments of great natural and unexplainable influences, which perhaps find their best definition in, 'man proposes, God disposes,' and which, as applied to ourselves, we have been pleased to call 'manifest Destiny.'

"Political forecast is therefore usually vain effort; it is more often, by far, wrong than right, but if one thing would seem sure it is that the East will be the scene, in not distant years, of one of the great dramas of social and material development. It may be that in the part which the possession of the Philippines will assist the United States to play, will be found the best justification of the treaty of Paris."

We trust that the works of Admiral Chadwick will be well read, that they will become popular,—not one of the "five best sellers," or gaged by any such superficial standard of worth, but that each sensible American citizen will get these books and study them and form his opinion from them, rather than from the wind-shifting garulity of chance newspaper utterances.

Officers' Manual. 5th Edition. By Captain James A. Moss, 24th U. S. Infantry, 6" x 8". 493 pp. il. Cloth. 1911. Price, $2.50, postpaid.

Supplement to Officers' Manual. June 1, 1911. By Captain James A. Moss, 24th U. S. Infantry. 5" x 6¾". 140 pp. 1 il. Paper. Price: Per copy, 60c; 3 years, $1.25.

Sales Agents: U. S. Cavalry Association, Fort Leavenworth, Kansas. Post Exchange, Fort Wm. McKinley, P. I.

To those of us in the service, the "Officers' Manual" by Captain James A. Moss, 24th Infantry, needs no introduction. It is worthy of note, however, that a new, revised, and enlarged fifth edition has just come from the press, and its compact form, with annual supplement, supplied for three years, at the nominal sum of $1.25, it is only natural for the JOURNAL to take pleasure in announcing this new work.

The book as originally published was the result of much study and effort on the part of Captain Moss, as well as the assistance given him by a number of Officers representing other arms of the service. It is clearly written, indexed, illustrated, and so arranged that the heart of the subject matter may be obtained with no appreciable effort. It cannot be said that this is true of all our service publications and in fact many are sadly lacking in this very necessary particular.

For many years previous to the original installment of this book, the service had been in need of "something," we did not know just what, but "something" that would cover a hundred and one little points, not found in the regulations nor ascertainable from anyone but the Commanding Officer. The Custom of the Service existed as an unwritten law, and there was nothing to teach the young Officer other than years of experience. It is the first and only book of its kind ever published.

This fifth edition has been completely revised by the author and it unquestionably contains the latest and most valuable information on subjects of a practical nature for younger Officers. A greater part of the information cannot be found in print. In addition to the revision much new material has been added. Captain A. L. Conger, late Instructor in Military Art at Fort Leavenworth, and one of the leading authorities of the Army, on these subjects, has completely revised that portion devoted to Military History and Personal Library. In some ten or twelve pages may be found a very complete list of books on Military History, covering the Napoleonic Wars, the Franco-German War, Early American Wars, The Civil War, The Boer War, The Russo-Japanese War, and many others. There is also given a list of memoirs by noted authors. Only the best selections have been made and the path is indicated whereby a young Officer can knowingly begin the neuclus of a Military Library, so necessary to us all.

A new chapter has been added on the Summary Court and also one on the Surveying Officer. Both of these subjects, however, lack flexibility and are confined to law and regulations.

It is interesting, at last, to see something definite on the subject of "Riot Duty." The long, laborious, non-get-atable, lingo of the law on this subject, has been put into a few words, simple, practical, and thorough in its interpretations. Both the legal and tactical sides of the matter are clearly presented, and in a way that no one can fail to comprehend. The chapter does not refer to Codes, Statutes, or voluminous decisions of the Supreme Bench—it tells you what to do. To say the least this departure is restful to the reader. Someone has written it with a working knowledge of conditions and the data

has been furnished from a source of experience. We, of the Regular Service appreciate the fact that the last means toward the suppression of Riot will have been exhausted before our time for action arrives. The problem is fairly well solved then before we begin. Our part is quick and effective action—this chapter leaves no doubt.

Captain Moss has made an effort to cover the whole subject for the young Officer, and with this addition one can hardly say that he has not done so in a clear and concise manner.

The annual supplement feature, which prevents the book from becoming obsolete, is to be continued. This is both new and unique in modern publications.

✦ ✦ ✦

A Military Word and Phrase Book. By Professor F. Sefton Delmer. Berlin, Germany: A. Bath, Mohrenstrasse 19. 4½" x 6½". 234 pp. 10 il. Canvas. 1912. Price, M3.60.

More than seven-eighths of this book is taken up with English phrases and their German equivalents. A table of contents analyses the subject matter. In this table, the English is given in one column, the German translation in a second, and the numbers of the pages upon which the phrases relating to each subject may be found, in a third column. The author says in a prefatory note that "the book is intended for the use of officers who are preparing for the Staff College Entrance Examination, or for the Interpreter's Examination."

The plan and scope of the work are the same as those of the Vocabulaire Militaire, by Professor von Scharfenort, the Librarian of the Kriegsakademie in Berlin.

At the end of the book are two short lists of military technical terms, the first, German-English, the second English-German.

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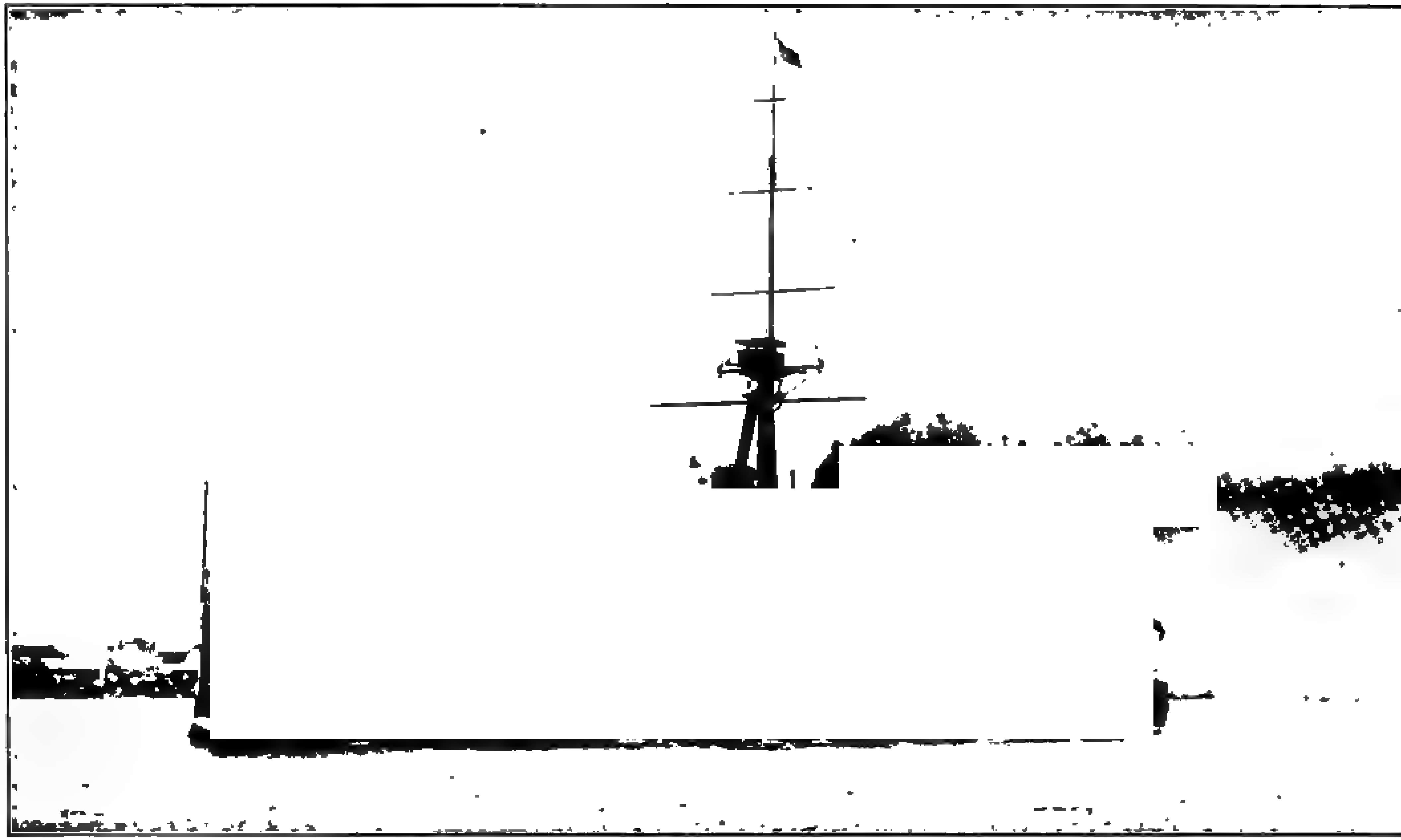
The United States Navy. By Henry Williams, Naval Constructor, U. S. Navy. New York: Henry Holt. 5¼" x 7¾". viii + 228 pp. 41 il. Cloth. 1911. Price, $1.50.

This is a somewhat unique work by a member of the Construction Corps, giving information of the most general sort concerning the Navy of the United States. The author was for a time on duty in the Navy Department in Washington. His duties frequently included the preparation of an unusual variety of replies to inquiries from many sources for facts about his profession. The need of some sort of a hand book of facts about the Navy for those who were interested in the enlisted men was also realized by the author. The book is the result of his desire to provide a work which should fill these two needs. He has apparently succeeded in accomplishing his object to a marked degree.

The book opens with about twenty pages of history of the Navy. It is no wonder that the men of our sister service are proud of their record. They have good ground for it. Yet we of the army might not be quite willing to agree that "the war against Spain in 1898 was almost entirely a naval war," as the author declares.

The second chapter describes the organization of the Navy Department, the duties of the Secretary, the Assistant Secretary, the seven bureau chiefs,



Photograph by Stephen Cribb, Southsea.

H. M. S. MONARCH

Displacement, 25,000 tons; length, 564 feet. Armament: 10, 13.5-inch and 20, 4-inch guns; 12-inch armor belt.

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*"La guerre est un métier pour les ignorans
et une Science pour les habiles gens."*

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WHAT IS THE BEST ORGANIZATION OF THE COAST ARTILLERY CORPS, U. S. ARMY, FOR TACTICAL CONTROL AND FOR ADMINISTRATION, INCLUDING ITS RELATIONS TO EXISTING STAFF DEPARTMENTS,—BOTH FOR PEACE AND WAR

BY CAPTAIN JOHN S. JOHNSTON, COAST ARTILLERY CORPS

ORGANIZATION IN GENERAL

Throughout this discussion the employment of the Coast Artillery Corps as Coast Artillery, only, will be considered.

Only two powers possess land frontiers adjoining our own. Our seacoasts are our only frontiers open to attack by other powers. Hence, the probability is very great that any attack upon our own home territory will open with attack upon our seacoast.

Due to the suddenness with which modern wars arise, there is no assurance that we shall have any time for preparation for war after such war shall have become imminent. Furthermore, we are superior in latent military resources to any probable combination of powers, but inferior in available military resources to any one first class power. Consequently, it will be the enemy's policy to complete his preparations before

permitting his belligerent intent to become apparent, to cut diplomatic discussion of the quarrel as short as common decency will permit and to strike us as suddenly and heavily as possible, in the hope of delivering a crushing blow before our strength can be brought to bear. Naturally, his first move will be an attempt to seize a base of operations.

This being the case, many situations are conceivable in which the outbreak of war would find the enemy's fleet upon our coasts. A glance at the position of the Japanese naval forces at the outbreak of the late war in Manchuria and that of the Italian naval forces at the outbreak of the present war between Italy and Turkey will demonstrate the reasonableness of this assumption.

As the Coast Artillery Corps provides the only troops permanently assigned to coast defense, these troops will probably have to meet the enemy's first attack, and meet it unassisted. They must, therefore, always be prepared to fight "at the drop of the hat," and will probably have to meet the first attack with the organization maintained in time of peace.

The organization of the corps should be designed to meet this condition; that is, it must serve the purposes of war as well as peace. And since there is a probability that the garrisons of coast defenses will have to be reinforced while under fire, the organization should be so designed that such reinforcement would not necessitate a reorganization of the command, but merely an expansion of existing units.

Organization for Tactical Control

Soldiers exist solely for the purpose of serving the weapons with which they are armed. To develop the maximum power of which these weapons are capable is the function of tactical control. The function of tactical organization is to enable tactical control to be exercised with a maximum degree of simplicity and certainty. Hence, the tactical organization prescribed for any body of troops must be based on and conform to the tactical employment of the weapons with which such troops are armed. The armament of the permanent defenses of our fortified waters constitutes the weapons of the Coast Artillery. Therefore, any discussion of the tactical organization of the Coast Artillery necessarily involves a consideration of the tactical employment of the armament which the Coast Artillery is designed to serve; and the organization adopted should be designed with a view to developing, by

the most simple and certain method attainable, the maximum power of which the armament is capable.

The elements of coast defense with which the Coast Artillery has to do are mortars, guns and mines. The tactical units into which these elements naturally divide themselves are batteries and mine fields; the latter being understood to refer to one or more groups of mines controlled from a common center.

Each unit, like every other unit in the military world, comprises materiel and personnel. These two elements should always be regarded as composing a single entity. Any other system introduces conflicts of authority, against which every consideration of military policy cries out.

The present system of assigning two or more organizations to a single artillery unit is vicious. The case of companies in battalion is not parallel. In a battalion, company commanders retain personal command of their companies. But commanders of organizations assigned with others to any artillery unit, if junior to the commander of the unit, are, practically, relieved of their commands while serving at such units. We have, then, the anomalous condition of an organization commander who has no authority over, or responsibility for, the most important part of the training of his organization. On the other hand, the commander of the artillery unit has but little control over the discipline and none at all over the administration or interior economy of organizations not under his immediate command. All these things are inseparably connected with tactical efficiency, and the commander charged with the one should also have control over the other.

There is no conceivable tactical excuse for the existence of the present unit organization of personnel. It does not conform to the requirements of any tactical unit; it invariably results in some elements of the defenses being either undermanned or over-manned; it is responsible for the policy of assigning two or more organizations to the same tactical unit and it tends to foster the idea that the artillery work of the corps is of secondary importance.

All the defects and difficulties cited above can be overcome by making the unit of organization of personnel conform to the tactical unit. The basic tactical unit is the battery or mine field; the basic unit of personnel, therefore, should be the personnel required for the service of any battery or mine field.

The accessories pertaining to the gun defense are usually assigned to higher units than the battery; but the number of men required to man these and the fire control equipment of higher units will generally be too small to form a separate organization. As a rule they will be drawn from the organizations pertaining to the higher unit requiring their services.

The proposed unit would lend itself equally as well as does the existing unit to the organization of the corps for field service; a contingency which, while of secondary importance, should be provided for wherever so doing does not interfere with the primary function of the corps. Organizations will be going concerns, and the strength of organizations could be equalized, where necessary, by transfers.

There is no reason why units should not be designated as they are at present; existing designations should, therefore, be retained.

The designation of the unit organization is non-essential. The essential difference between the existing organization and that proposed lies in the fact that under the proposed organization a battery, say, would consist of a coast defense work with its armament and accessories *and* the personnel appropriate to its efficient service; whereas, under the existing organization, the battery in question consists of a coast defense work with its armament and accessories *to which one or more organizations, organized and equipped as infantry but designated as coast artillery and serving, temporarily, as coast artillery, are, temporarily attached.*

The distribution of companies should be effected as follows:

From the number of companies authorized by law deduct one company for each unit of the coast defenses of our insular possessions. The companies remaining available for service in the United States should be distributed among the harbor defenses of our three coast lines so that the units of defense manned by them would afford the most effective protection to the country, as a whole, that could be rendered by any like number of units. The apportionment should be based on the relative strategic importance of different harbors and the relative tactical value of the several units of artillery defense in each harbor.

The problems attending this apportionment are beyond the province of this discussion, and will not be discussed here farther than to say that the selection of the particular units to

be manned should be considered as a local problem, to be solved independently for each harbor; that in each harbor selected for defense the units to be permanently manned should, at least, be capable of preventing any hostile raiding force from entering or bombarding the harbor and that in selecting the units to be manned no weight should be given to any consideration whatever except their relative tactical value.

The units to be permanently manned having been selected, a company should be assigned to each of these units, and the strength of each company should be fixed at

The number of officers and enlisted men required for one complete manning detail for the unit to which the company is assigned, plus

One 1st Sergeant, one Mess Sergeant, one Cook, for each 30 men,

The company's proper quota of the manning details for accessories,

A reserve amounting to 25% of total strength required for the details enumerated above.

The existing organization of personnel for the service of gun and mortar batteries is excellent and should be retained.

The organization prescribed for personnel assigned to mine defense should be retained, but amended so as to provide for an additional officer, who should have charge of the mining casemate, and a storekeeper, a non-commissioned officer, who should be given a rating corresponding to that of Chief Loader, or Chief Planter. The mining casemate is the heart of the mine defense, if it goes out of action the mine defense is paralyzed; and the loss of the mine defense would be the most serious blow that could fall upon the defense of a harbor. The property pertaining to a mine field is so great in quantity and so varied in character, and during the instruction period it must be in the hands of so many men at so many different places, that the whole time of one exceptionally efficient man is required to properly keep trace of it. The officer responsible for the property is very rarely able to devote much of his time to looking after it, and it is unfair to him to saddle him with such a load of property without providing for any one to assist him in taking care of it.

For efficient tactical control the units of the artillery defense must be joined together in groups. The problem of arranging these groups so as to best serve the interests of tactical control is somewhat complicated by the heterogeneous

character of the armament of our harbor defenses, the, seemingly, haphazard manner in which the armament has been sited, and the almost endless variety of tactical situations which the defenses may have to meet.

In addition to mortars and mines, there will be found in defenses of nearly every fortified harbor, guns of at least four different calibers, and the variety is usually greater than that.

The attack may take the form of any one, or any conceivable combination, of the following operations:

Distant bombardment.
Reconnaissance.
Attempt to cripple mine fields.
Attempt to force passage into harbor.

The number of the variations that might, conceivably, be introduced in the delivery of any given form of attack is well nigh infinite. We must, therefore, organize our heterogeneous armament so as to put it in the best possible position to meet any conceivable form of attack.

The guns employed in our harbor defenses may be grouped in four general classes:

1. Those ineffective against armored targets at any range.
2. Those ineffective against heavy armor at any range, but effective against light armor at short range,
3. Those more or less effective against light armor at all ranges and against heavy armor at short ranges.
4. Those effective against medium armor at all ranges and against heavy armor at mid and short ranges.

The first class includes all calibers below 6-inch; the second, 6-inch and 8-inch; the third, 10-inch; the fourth, 12-inch and above.

Mortars are in a class by themselves, being effective against all classes of targets anywhere within their range limits.

The attacking force may be composed of vessels of a single class or of several classes, but the latter will probably be the case. If the attacking force is of any considerable size, it will probably be divided into squadrons, or similar groups. For tactical reasons, each squadron, or other group, will, ordinarily, comprise vessels of similar characteristics, only. As a rule, then, the groups composing the enemy's fleet will be composed of vessels of one of the following classes:

1. Unarmored vessels. (Torpedo craft, mining vessels, etc.)
2. Vessels protected by light and medium armor. (Cruisers.)

3. Vessels protected by medium and heavy armor. (Battleships.)

These classes of vessels agree approximately with the respective classes into which the guns of the defenses were divided, and, to obtain a maximum effect from the fire of any battery, its fire should be directed at a target suited to the capabilities of its guns. The defenses, therefore, should be organized with a view to facilitating such a distribution of the fire of its batteries.

Furthermore, the Coast Artillery's only opportunity to exert a positive influence on the course of a war will lie in its chance of destroying, or crippling, such of the enemy's vessels as come within range of its guns. Therefore, when the enemy's vessels do come within range, it should always endeavor to destroy or permanently cripple them, not merely to drive them away. Hence, every gun in action should be assigned to a target suited to its capabilities, so that a destructive fire may be opened at a maximum range. In grouping batteries for tactical control this idea must be kept in view.

The object sought in uniting batteries in groups is to make it possible to administer their fire so as to obtain from the fire of the group, considered as a unit, a maximum return for the ammunition expended. The function of the group commander is to distribute the fire of his group so that the effect tought will be obtained. He has no means of estimating the effect of his fire, except to observe the condition of the target, or targets, upon which he is firing. He can keep under constant observation only such targets as are contained, simultaneously, in the field of his telescope. He cannot observe effectively targets that are widely separated. Hence, efficient fire direction demands that he either concentrate all his batteries on a single target or distribute their fire among targets that are closely grouped; and such groups would, ordinarily, be composed of vessels of a single class. Hence, the fire of all the batteries of a given group will, ordinarily, be directed against the same target, or targets of the same class; the batteries should, therefore, all be armed with guns of the same class. It would then usually be possible to assign the group to a target suited to the capabilities of all its batteries, or to a group of such targets so placed with respect to each other as to simplify the problem of group fire control. On the other hand, if the group comprised guns of different classes it would probably never be able to develop its maximum fire effect.

For in order to assign each battery to a target suited to its capabilities it would probably be necessary to distribute the fire of the group among different groups of the attacking fleet, and consequently, among targets so widely separated as to preclude efficient group fire control, or, if the fire of the batteries were concentrated so as to secure efficient fire control, some batteries would probably have to engage targets unsuited to their capabilities.

Operations under cover of darkness will doubtless form an important feature of any future attack upon a fortified harbor. The foregoing remarks apply with peculiar force to the conditions attending night attacks. For here the problem of searchlight control will compel the group commander to confine the fire of his group to a very few targets, at most, and these very near each other.

It appears, then, that the organization best adapted to developing the maximum power of which the armament is capable, requires that batteries be grouped together so that each group shall comprise guns of similar capabilities, only; each group being assigned to a function suited to the capabilities of its guns.

Referring to the classification of guns and vessels, page 130, the first class of guns is effective against the first class of vessels, only. The only conceivable function of such vessels in the attack of a fortified harbor would be to attack the mine fields. Hence, guns of the first class should be attached to the mine defense. The manning parties for these batteries should be drawn from the mine companies, as at present.

Six-inch and 8-inch guns cannot attack effectively targets protected by armor of any class at anything except short range. Armored targets will not approach within short range of the batteries unless they have decided to attempt to pass the batteries. They will not attempt to pass the batteries so long as the mine fields are intact and in our possession. By their fire these guns cannot keep the enemy's heavy vessels at a distance nor contribute materially to that end; but they can do so, indirectly, by assisting to preserve the integrity of the mine fields. Also, the mines are the backbone of the defense; they constitute as near an impassable marine obstruction as human ingenuity can devise. So long as the mine defense of a given harbor is intact, that harbor is absolutely closed to hostile vessels. Therefore, the most certain means of excluding the enemy from a harbor is to preserve the integrity of the mine

fields pertaining to the defenses of that harbor. Then, the essential features of the defense of a harbor are the prevention of bombardment and protection of the mine fields. The 6-inch and 8-inch guns are useless for the former purpose but valuable for the latter; they should, therefore, be attached to the mine defense.

However, as to obtain efficient service with these guns requires as much, if not more, training than is the case with guns of the primary armament, the personnel assigned to their service should devote all of its time to training in the service of the battery. It should not, therefore, be drawn from the mine companies, but should compose a separate gun company for each battery.

Following the system of grouping proposed above, the remaining classes of guns and the mortars should be assigned to the gun defense and be grouped as follows:

a. 10-inch guns.

b. Guns heavier than 10-inch.

c. Mortars.

Following the existing practice, these groups will be designated as Mine Commands and Fire Commands; but their organization will vary materially from that of the groups to which these designations are applied at present.

In order to assure perfect co-ordination among the various elements of the mine defense, such of these elements as are designed to serve a common purpose should all be subject to the control and direction of a common head. A mine command, therefore, should comprise all the submarine defenses of a given channel or entrance, all guns assigned to the protection of these defenses and all accessories pertaining to the mine defense of the channel or entrance in question.

The Mine Commander should be charged with the tactical control of all elements of the mine defenses pertaining to a given mine command. Commanding officers of mine companies would be in direct charge of everything connected with the service of the mine fields to which their respective companies were assigned. Since the mine command will usually comprise several different units, the Mine Commander should stand in the same relation to the mine command as do Fire Commanders to the gun defense. Manning parties for fire control and other accessories of the mine command should be the same as those at present prescribed for fire commands.

Admitting that the prime object of gun defense is to

inflict upon the enemy the greatest possible amount of physical injury, not merely to drive him away, batteries should be grouped together with a view to developing in the briefest possible space of time the heaviest fire that the armament is capable of concentrating on a given target. To meet this condition, all batteries capable of firing effectively at the same target at all ranges should be united under the control of one officer. Hence, all batteries of the same class, bearing on the same channel, should constitute a single fire command.

It is hardly probable that any such fire command would contain so many guns that ammunition would be wasted. The object in view in grouping them is to secure celerity of concentration and certainty of effect, and a few rounds more than are necessary to produce the effect sought are not wasted if expended in making sure that the result has been attained. It would seem that any limitation as to the number of guns in a fire command must be based on some assumption either as to the number of batteries whose fire can be controlled by one man or as to the "number of rounds required to put a ship of a given class out of action." A little reflection will show that the Fire Commander's ability to distribute the fire of his command is limited only by the number of targets that he can keep under observation, and is entirely independent of the number of batteries firing. As to the second assumption, recent experimental firings seem to demonstrate that a single shell exploding in the right place may suffice to put a ship out of action, while the same ship may be struck an indefinite number of times by the same sort of shells without being permanently injured. It seems rather futile to attempt any assumption relative to a quantity whose value varies between such wide limits.

But the relative location of the batteries in the defense of most of our harbors will preclude the formation of separate commands organized as proposed above. For the defenses of most harbors include one or more groups so isolated as to require a separate land defense. Such groups should constitute separate sub-divisions of the artillery defense. For the land defense of the group must necessarily be in charge of an officer stationed within the group. This officer must have subject to his orders, for purposes of land defense, all troops attached to the group, including personnel of artillery units. There must be no question as to when his authority over the latter troops begins and ends; consequently he must be in command at all

times. Also, the communications of such groups with the Battle Commander are liable to interruption; and such a contingency should not necessitate a break in the continuity of action of the group.

The tactical relation of such groups to other units of the defense would be similar to that of detached posts to the other units of a line of battle. Hence such groups might be appropriately designated as "Detached Posts," and they will be so designated hereafter.

But this division into separate commands must not be permitted to interfere with the employment as units of the various classes of guns comprised in their armament. But these detached posts, being separate commands, should, properly, receive orders only from the next higher commander, the Battle Commander. Hence, the duty of combining the fire of the different classes of batteries would devolve upon the Battle Commander. But since, for reasons already stated, no one man can efficiently control the fire of a number of batteries pertaining to different classes, the Battle Commander must perform this duty through his staff. His staff, therefore, should include a Fire Commander for each class of guns and mortars comprised in the battle command, except guns pertaining to mine defense, and a Mine Commander in charge of mine defense and guns pertaining thereto.

Orders for batteries pertaining to detached posts would be transmitted through the commander of such posts, whose duties would be confined, normally, to seeing that such orders were carried out.

For facility in indicating targets and transmitting orders and instructions it would be preferable to station the Fire and Mine Commanders in the same station with the Battle Commander; but this is not essential to the feasability of the scheme, and whether or not it is done should depend entirely on the arrangement of the fire control installation.

The defensive works guarding a given channel or entrance to a harbor are designed to act as a unit in the accomplishment of a common purpose. The groupings proposed above constitute only one step toward that end. To insure their complete co-ordination they must be united in a single command. Following the existing system, this command will be designated as a "Battle Command."

The function of the battle command, as indicated in the preceding paragraph, is to insure co-operation and co-ordination

among the elements of defense covering a given channel or entrance to a harbor. It should, therefore, include all mines designed to block the given channel or entrance, and all guns and mortars bearing thereon, together with all accessories pertaining to such mines, guns and mortars and the personnel assigned to their service. The Battle Commander should be responsible to the District Commander for the proper maintenance of the materiel, and the proper instruction of the personnel pertaining to his command. In addition to the fire and mine commanders, the battle command manning party should include all the details provided for in "Drill Regulations for Coast Artillery" and an additional detail for each fire and mine commander similar to the fire command manning party at present provided for by Drill Regulations.

Finally, all the defenses designed to protect a given harbor or other body of water should be united under one supreme artillery commander, to the end that all may be co-ordinated so as to mutually supplement and support each other. The existing artillery districts serve all purposes of this grouping.

Comparing the district with a field force, the District Commander is the chief who plans, provides for and co-ordinates all operations of the defense in the theater of operations included in his command; battle commanders are in charge of more or less distinct but correlated sections of the theater; fire and mine commanders are chiefs of the different elements composing the force assigned to the defense of each section and battery commanders command the units into which these elements are divided.

The District Commander should exercise supervision over the defense of his entire district, land as well as sea front. He should not, therefore, be placed in a position which may require him to devote his entire attention to any one portion of his command. Consequently, in a district containing more than one battle command, the District Commander should not be a battle commander.

Any of the higher units or subdivisions enumerated above may comprise only one unit of the next lower subdivision or it may comprise several of such units. In any case each subdivision should have the organization appropriate to its composition, so to speak, rather than its designation. For instance, a single battery may, for tactical purposes, be designated as a fire command or a battle command; but it should, nevertheless, retain the organization of a battery. For the only actual dif-

ference that can possibly be introduced in its status by designating it as a higher unit will result from attaching to it certain accessories; and these will, of course, not require a separate organization for their service.

The defense of its sea front will probably constitute a minor part of the problem of preventing an enemy from occupying a given harbor.

The function of these seaward defenses may be likened to that of a stone wall blocking the harbor entrance. So long as the wall remains intact the enemy will hardly attempt to force a passage through it, since such an attempt would be almost certainly foredoomed to failure and would probably involve the destruction of vessels engaged in it. But should some such obstruction be lacking, or should a breech have been made in the obstruction, the enemy would certainly attempt to force an entrance from the sea. For to an enemy attempting to effect a lodgement on our coast, a harbor would be a necessity and time a factor of paramount importance; and, obviously, the speediest method of taking possession of a harbor would be to sail directly in from the sea. Therefore, to prevent the enemy from entering a harbor, it is only necessary to preserve the integrity and efficiency of the shore defenses of such harbor; so long as these remain intact and in working order, they may never be required to put forth a single effort in defense of their sea fronts.

It appears then that as long as our seacoast defenses are manned and maintained in a proper state of efficiency, that their mere existence will accomplish the purpose which the defenses were designed to serve, viz., to prevent hostile vessels from gaining access to our harbors. Due to their location and construction, very few of the elements of these defenses are susceptible of being put out of action by naval bombardment. Batteries, as a rule, can be put permanently out of action, only, by attack from the rear. Then, the land defense of the fixed harbor defenses is one of the most important factors in the problem of defending a harbor against attack from the sea, and must be considered in any plan for such defense.

The land defense referred to here and throughout this discussion includes only the immediate, or local, defense of the rear, or land, front of the fixed defenses, and not to the general land defense of the locality in which the defenses are situated.

The first attack on a fortified harbor will probably consist of, or at least include, an attack on the land front of the fixed

defenses. For reasons explained in the opening paragraphs of this discussion, the defenses must always be prepared to meet such an attack.

There are no troops permanently assigned to duty with the coast defenses, except coast artillery. For some time to come, at least, it is improbable that the mobile army will be able to spare any troops for such duty. Nor is it desirable that regular troops should be assigned to such duty. The organized militia will doubtless be able to furnish troops who will fight as well behind intrenchments and on the passive defensive, and every regular soldier available will be badly needed for other duties. The coast artillery must, therefore, be prepared to take care of the land defense of its fortifications until relieved by other troops.

As the land defense of a given harbor is purely a local problem, no attempt should be made to prescribe the details of organization of troops assigned to that duty. But some plan for the local land defense of every fortification should be worked out in the most minute detail. The organization of the personnel best adapted to the details of this plan should be determined, and every member of the command should be assigned to some definite duty in connection therewith.

The preparation of these plans, at least, will devolve upon the coast artillery; such may, or may not, be the case with their execution. In either event, the District Commander will be in command. He should be represented on the land front by an officer whose function with respect to land defense would be similar to that of a battle commander with respect to the artillery defense. Considering the importance of this detail and the fact that duties in connection with the land defense may require him to command all, or any part of the coast artillery troops, this officer should be next in rank to the District Commander. This officer should be in direct charge of everything connected with the carrying out of all plans for land defense, and where no such plans exist, he should be charged with their preparation.

This completes the tactical organization. So far as the artillery defense is concerned, higher units are of no value. The only object of unit command is to insure among the subdivisions of the command such a co-ordination of effort as will produce a maximum of effect upon a common objective. But the fixed defenses of no two districts can have a common objective, neither can they support each other. For all the fixed

defenses of a given harbor, or other body of water, should be comprised in one district, and fixed defenses can support each other only by their fire. Hence, to have an objective common to two districts, or two districts capable of mutually supporting each other, we must have two separate fortified bodies of water, a part, at least, of whose armament has a common field of fire; a condition which should not exist.

It is believed that the organization proposed meets all requirements of the problem. It provides a simple and direct means for quickly developing the maximum power of the armament; the organization of the artillery defense does not interfere with, but rather, lends itself to the organization for land defense and is so designed that passing from a peace to a war basis should involve no re-distribution of units, no re-organization of commands, nor any other change, except putting additional units in commission.

Organization for Administration

If practicable, the administrative organization should be such that passing from a peace to a war footing would necessitate no reorganization, but merely an expansion of the existing organization.

The duties devolving upon the administrative organization in time of peace are as follows:

1. Procurement, installation and maintenance of ordnance materiel.
2. Procurement, installation, operation and maintenance of apparatus for the generation and distribution of power.
3. Procurement, installation and maintenance of fire control materiel.
4. Procurement, preservation and issue of food.
5. Provision and maintenance of water supply.
6. Procurement, preservation and issue of clothing and equipage.
7. Erection and maintenance of barracks, quarters, and other buildings, roads, walks, etc.
8. Conduct of correspondence and keeping of records.
9. Enforcement of discipline.
10. Care of sick and injured.
11. Sanitation.

No effort has been made to enumerate these different duties in order of importance. The two last will doubtless remain in

the hands of the Medical Department, and need not be considered further in this discussion.

All the foregoing functions must be exercised in war as well as in peace; hence, there is no intrinsic necessity for any change in the administrative organization in passing from a peace to a war footing.

The administrative organization should conform to the needs of the tactical organization.

In considering how to meet this condition, but little is to be gained from a study of the methods in use in mobile armies. The problems presented are analogous under peace conditions, but altogether dissimilar under war conditions. In the case of mobile troops, the administrative organization for war is based on the assumption that the troops will be in the field; in the case of the Coast Artillery, the organization must be based on the assumption that the troops will be in garrison and must keep in view the possibility that the garrison may be besieged and thus left dependent on its own resources.

The functions enumerated in the list shown on the preceding page may each be assigned to one of three general groups, viz.,

Those having to do with materiel.
Those having to do with supplies, and
Those having to do with personnel.

"Materiel" is understood to include the armament of the works, the arms of the personnel, and all the ammunition, accessories, implements and materials designed to be used in connection with such arms and armament, and "supplies" to include everything intended to serve the health, comfort and convenience of the personnel.

Certain services will be required in common by both "materiel" and "supplies", viz., repairs, transportation, and, to a lesser extent, construction. By far the greater part of repairs will be required by "materiel" and transportation, and a large percentage of the transportation work will be performed in connection with construction and repair work, and repairs and transportation will comprise, practically, all the fatigue work to be done.

It appears then that all the services required in connection with administration are intimately correlated and interdependent. They should, therefore, all be under one head; and, since they are required by both "materiel" and "supplies," they should, to avoid friction, be assigned to neither. The

administrative staff, then, should be divided into the following sections:

a. Personnel.
b. Materiel.
c. Supplies.
d. Services.

While the titles to be given the chiefs of the different sections are not an essential feature of the proposed organization, the following are suggested:

Section a. The Adjutant.
Section b. The Ordnance Officer.
Section c. The Commissary of Supplies.
Section d. The Maintenance Officer.

The duties to be performed by the different sections of the staff would be as follows:

Section a. Take charge of correspondence and records and enforcement of discipline.

Section b. Obtain, care for while in storage, issue and account for the armament of the fixed defenses and land defense, the arms and accouterments of the garrison, submarine mines, searchlights, machinery and apparatus for generating power, fire control materiel, explosives, ammunition and components thereof for armament and arms, and all spare parts, instruments, apparatus and materials used in the installation, repair and preservation of the foregoing; in general, everything designed to be used in direct connection with the defenses of both land and sea fronts.

Section c. Obtain, care for while in storage, issue and account for food supplies; clothing; camp and garrison equipage; means of transportation by land and water; all materials used in construction, preservation and repair of means of transportation, roads, walks, barracks, quarters and other structures; fuel; forage; stationery and illuminating supplies; provide and maintain an adequate supply of potable water; in general, provide everything necessary to the maintenance of the garrison.

Section d. Take charge of the construction and repair of roads, walks, buildings and other structures; install and repair the armament and its accessories; install, operate, maintain and repair all power plants, repair plants, pumping plants, condensing plants; operate the transportation service and keep means of transportation in repair; in general, perform all services required by both armament and personnel. In the pro-

posed organization of the administrative staff, an effort has been made to meet several conditions that do not exist in other branches of the service.

1st. The diversity and multiplicity of administrative duties.

2nd. The combination of field and garrison conditions that exists, especially in time of war.

3rd. The many points at which the functions of the different supply departments with respect to coast defenses overlap, and the consequent unscientific and uneconomical duplication of supplies and services.

The latter condition is probably the most serious defect in the existing administrative system. In every artillery district, and probably at every coast defense post, there will be found tools, hardware, and electrical supplies of the same character supplied by the Signal Corps, the Engineer Department, the Ordnance Department, and the Quartermaster's Department. And in many cases the tools, supplies, etc., supplied by one department are duplicates of articles supplied by each of the others, and not needed in the administration of the post and supplied with no other end in view than to make the department concerned "self-supporting." In most, if not in all, artillery districts the Ordnance Department maintains a well equipped machine shop and the Quartermaster's Department an equally well equipped blacksmith shop; but, as a rule, neither of these shops is expected to do any work for any department except its own without a lot of preliminary "red tape." These two shops combined, together with a wood working shop, under one management, would doubtless be able to handle easily all the repair work of any district.

But the existing laws relating to appropriations and the system of accounts employed in the War Department would probably preclude the maintenance of such a repair plant. The difficulty would arise from the fact that maintenance charges against the armament, power installations, transportation, barracks and quarters, etc., must be paid out of funds appropriated for these respective purposes, and funds appropriated for any one of these purposes cannot, legally, be used for any other. Hence, the cost of operating a common repair plant would have to be apportioned among the various appropriations against which the repairs undertaken would be legally chargeable; and it would be difficult, if not impracticable, to evolve a system of cost accounting that would show,

even approximately, the actual percentage of operating cost assessable against any given appropriation.

However, it will be seen that the difficulty is entirely a matter of accounts; and it would seem to be a simple matter to change the wording of appropriation acts and the accounts of the different supply departments so that funds or materials supplied to Coast Artillery districts for maintenance purposes might be used in the repair or maintenance of any public property in the district, regardless of the department or appropriation from which such funds or materials were obtained.

Administration should have only two ends in view: Efficiency and economy. In fact, these two ends may be said to be identical. For a mere reduction of cost, obtained at the expense of efficiency, is not economy; and mere perfection of operation obtained at an exorbitant cost, is not efficiency. Efficiency is, of course, the main consideration; and any *necessary* expense incurred in promoting efficiency is a measure of economy. But wherever a reduction of expense can be effected without impairing efficiency, both economy and efficiency demand that it be done. Comfort and convenience are entitled to consideration only in so far as they promote efficiency. Administrative duties, then, should be so distributed among the district and its subdivisions as to insure the greatest economy of administration consistent with efficiency.

The district, being the highest unit of organization in the coast defense service, should be the chief administrative unit. All administrative activities in the district should center at district headquarters, and the district should contain the least number of administrative centers consistent with efficient administration. For, roughly speaking, consolidation of administrative centers is always a measure of economy, since it tends to consolidate duties and thus to reduce the personnel of the administrative establishment.

The number of such centers in any district will be governed by the distribution of personnel; which, as previously explained, should be governed solely by tactical considerations. To leave unmanned, a battery or other unit essential to the defense of a harbor because of the expense involved in keeping it manned, would be false economy of the worst kind; and troops should always be quartered in the immediate vicinity of the units of defense to which they are assigned.

The coast defenses should be prepared for action at any hour of any day or night, and batteries long "out of commission" can never be put in condition for efficient service without indefinite delays. There are invariably a number of little "defects and deficiencies" which only become apparent through continual handling of the materiel, any one of which would put a gun or battery out of action. Fire control materiel must be taken out of storage, assembled and adjusted; and almost always some small, but essential part, or some of the data necessary for adjustment, is missing. Communications always develop obscure troubles which must be searched out and corrected.

It is all well enough to say that these defects should be discovered during the prescribed inspection of materiel out of commission, but the fact remains that they might very easily be, and usually are, overlooked at such inspections, that they would certainly be discovered if the materiel was in constant use and that any one of them might put a gun or battery out of action indefinitely. In short the condition of materiel in constant use is, at least, a known quantity while that of materiel out of commission is, at best, conjectural; and, in a matter of as grave importance as the defense of an important harbor, the consideration must be weighty indeed which leads us to choose uncertainty when certainty is attainable.

But the administrative organization, like the tactical organization, should be such that no vicissitude of battle or siege would necessitate a reorganization. Hence, every unit, or group of units, which is liable to be isolated from the rest of the district should form an administrative sub-division of the district. If no such tactical necessity for subdivision exists, the district should be administered as a single unit. As a rule, these subdivisions would coincide with existing posts and subposts. All existing posts in artillery districts should be discontinued as posts and those that are to constitute administrative subdivisions of districts should be so designated.

The administrative functions of subdivisions would be limited.

There should be but one depot of supplies and materiel in each district. The subdivisions of a district are always situated near enough to each other, and transportation facilities are, or should be, ample to enable all to be supplied from a single depot. Since stores would be handled in greater bulk in such depots than they are, as a rule, at present, they would

be handled much more economically. Furthermore, supplying the district from a central depot would do away with the expense of maintaining others and would put a stop to the accumulation at every post of a lot of valuable, but useless, stores.

Stores should be issued to subdivisions and organizations by the district depots in the same manner in which they are now issued by post supply officers.

In time of peace, wherever the communications of any subdivision with the district depot are liable to interruption, each organization in the garrison of such subdivision should be required to keep on hand a reasonable quantity of food supplies. Upon the first indication of impending hostilities, a depot of supplies, conducted as a branch of the district depot, should be established in each subdivision.

One general repair plant will usually be sufficient for a district. This plant should do all repair work in the district, of whatever nature, requiring the services of skilled labor or involving machine work of any kind.

In a district containing only one garrisoned subdivision, all staff duties should be performed by the district staff. But where a district contains more than one garrisoned subdivision, the district administrative organization should stand in the same relation to the subdivision containing district headquarters as to all other subdivisions.

The distribution of administrative duties in the district and its subdivisions should be as follows:

The District Commander should have general control of the administration of his entire district. He should be assisted by a staff consisting of—

An Adjutant,
An Ordnance Officer,
A Commissary of Supplies,
A Maintenance Officer.

The Adjutant, in addition to the duties now assigned to the District Adjutant, should perform the functions of chief of staff to the District Commander. The District Commander should be authorized to turn over to him routine matters of administration such as the approval, or disapproval, of requisitions on the district depots, etc.

The Ordnance Officer should have charge of all the duties previously enumerated as devolving upon the section of "materiel."

The Commissary of Supplies should have charge of all the duties devolving upon the section of "supplies."

The Maintenance Officer should be in charge of the district repair plant and all water transportation pertaining to the district and should have general oversight over the maintenance and repair of the armament and accessories of the entire district.

Commanding Officers of subdivisions should perform the same functions that devolve at present upon post commanders; but in all administrative matters they should be directly responsible to the District Commander, and their requisitions for supplies would be submitted to district headquarters instead of going to the different supply departments.

In subdivisions garrisoned by two or more companies, the commanding officer should be assisted by a staff consisting of an Adjutant and a Maintenance Officer.

The Adjutant would perform the functions at present devolving upon post adjutants, and in addition should be in immediate charge of all duties pertaining to the land defense of the subdivision. He should also be, *ex officio*, summary court and surveying officer.

In any subdivision garrisoned by less than four companies, the relief of an officer from other duties in order to serve as adjutant should be prohibited, when so relieving him would reduce the number of officers with any battery to less than two and with any mine company to less than three, and in a subdivision garrisoned by one company only, no adjutant should be detailed.

At small posts the adjutant rarely, except at infantry formations, performs any duties that could not be equally well performed by any competent clerk. In such circumstances, the detail of an officer for such duty is a useless waste of the officer's time, and to relieve him from any important duty for such a purpose would be utterly unjustifiable.

In all subdivisions an officer should be detailed for duty as maintenance officer.

The Maintenance Officer should be in charge of all minor repairs of every kind and all fatigue work and services required in the administration of the subdivision. He should be responsible for all tools and implements, fuel, forage and transportation, pertaining to the subdivision and for all materials, spare parts and supplies intended for use in making repairs and not in the hands of organizations.

All property, of whatever nature, should be held on memorandum receipt to the proper district staff officer, who should account for it.

As there would be no property on hand in any subdivision that would not properly be in the hands of the Maintenance Officer, or some officer or organization, the supply departments need not be represented in the administrative staff of the subdivision.

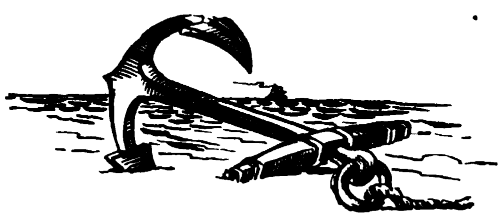
The noncommissioned staff should be left as it is at present, in so far as concerns its general composition, except that Master Electricians should be given warrant rank. These men usually have duties of greater importance, requiring a higher order of technical knowledge and skill, than any other class of enlisted men in the line of the army. Their special situation entitles them to special consideration.

Battery Commanders should perform the same functions with respect to the personnel of their batteries as do company commanders with respect to their companies. Since the efficiency of the battery depends, to a very great degree, on the discipline of the personnel, the battery commander should have charge of such discipline. For similar reasons he should have charge of the interior economy of the company composed of the personnel of his battery. He would also, logically, be required to care for the quarters occupied by his men. If he is responsible for the discipline and interior economy of his company, he should have at hand the records of his men. If he is in charge of the records of his men, he should also prepare the rolls and returns of personnel.

For the foregoing reasons the senior officer on duty with a mine company should perform the functions of company commander for that company.

All property in the hands of the companies would be held on memorandum receipt to the district staff officer accountable therefor.

The existing corps organization should be retained.



THE U. S. NAVAL WAR COLLEGE

By Major GEORGE A. NUGENT, Coast Artillery Corps
General Staff

Having had the good fortune to be detailed to attend the Summer Conference of Officers at the U. S. Naval War College during the summer of 1911, the writer takes great pleasure in here presenting his impressions for the benefit of the Coast Artillery at large.

Both the army and the navy form the defense of the country in time of war. If the object of the war is to be successfully attained with the minimum loss, the operations of these two great branches of our national military forces, in time of war must be efficiently co-ordinated. Co-ordination, under our military system, involves co-operation; and to effectively co-operate, each service must know the points of view of the great body of officers, and the aims and limitations, in fact the personal equation so to speak, of the other. Our war plans, keeping in view the object of the war, must assign to each its proper share within its own sphere. The war plans when complete, should contain the part each service is to take in the prosecution of the war; and it would seem that each service should have its voice in the preparation of any plans involving joint operations, which would include every possible war plan.

Co-operation in time of war is greatly aided if each service has some personal acquaintance with the other. This acquaintance can be brought about in various ways, among them;—the athletic contests between the two service academies and between teams of enlisted men; by the exchange of visits and hospitalities among officers afloat and ashore; by the exchange of officers in attendance at the service schools and war colleges. The last is deemed of the greatest importance, as thereby, selected officers who in time of war may exercise high command or staff duty, are thus brought in touch, in a professional way, with the sister service. They find out what may be most probably expected from the other service in time of war; they learn something of the methods and professional

opinions of the officers of the other service; and if at the war colleges, they assist in the preparation of the war plans. A start on the interchanging of officers has been made in the detailing of army officers to attend the summer conferences at the Naval War College, and in the detailing of navy and marine officers to attend the Army War College, and marine officers to the Army Service Schools at Fort Leavenworth. Along the same line is the detailing of officers of the Coast Artillery Corps to attend fleet target practices, which it is to be hoped in the near future may be extended to include the detailing of two or three coast artillery officers each year to the Naval War College, and naval officers to attend the Coast Artillery School.

The Naval War College was formally established by General Order No. 325, Navy Department, dated October 6, 1884; which order also provided general regulations as to the supervision of the college, the arrangement of the courses of study, etc., and assigned (then) Commodore S. B. Luce, U. S. Navy, to duty as the first president.

The above order was issued to carry into effect the recommendations of a board of officers, consisting of Commodore S. B. Luce, Commander W. T. Sampson, and Lieutenant-Commander C. F. Goodrich, constituted by the Secretary of the Navy to consider and report upon the whole subject of an advanced course of professional study for officers of the navy.

The board outlined a course of study to last six months and recommended very strongly, practical exercises in combination with the North Atlantic Squadron during the summer or autumn months.

The board recommended the establishment of the War College at Coasters Harbor Island in Newport Harbor, R. I., on account of the facts, the Department already possessed a reservation of 100 or more acres on that island; the Torpedo Station, located then as now on Goat Island, was conducting a course of instruction each year for officers, and the same class might be available for both courses; and Newport Harbor, on account of its proximity to the sea, offered exceptional advantages for the conduct of the practical exercises afloat considered by the board such an essential part of the course.

The first class of officers, eight in number, reported upon the 4th day of September, 1885. The course lasted for one month.

Since that time each year, except 1890, 1891, 1893, and 1898, a number of officers have assembled at the college to

take the course, which has increased in length from one month the first year to four months, the length of the summer conferences as now held. The number of officers in attendance has varied greatly from year to year, owing to the shortage of officers in the navy. In 1894 the date of commencement of the course was changed to June 1st. Until within the past two years instruction has been given entirely by lectures and oral discussions.

Lectures were given on military and naval history, strategy, tactics, coast defense, gunnery, hygiene, international law, the naval war game, etc. The list of lecturers includes the names of many army and navy officers who have risen to great prominence. Since 1901 the study of International Law questions has had great prominence in the course. Each year a number of situations are laid down for discussion. Solutions of these "Situations" are prepared in committees and later the solutions of the committees are discussed in conference under the direction of some eminent authority on International Law. Since 1902 Professor George C. Wilson, Professor of International Law at Brown and Harvard Universities, has been the lecturer on International Law. The annual published volume of the Naval War College on the International Law work of the year has come to be regarded as an authority on the subject of which it treats.

Two years ago an applicatory system of study, similar to that in use at the Army War College and at the Service Schools, was introduced. The College is endeavoring to cultivate in the minds of the officers of the navy the habit of systematic reasoning in approaching tactical or strategical problems, such as is given by an "Estimate of the situation." An effort is also being made to develop a form of "Campaign Orders," modifying our field order form to suit their needs and varying conditions.

The main building now occupied by the Naval War College was completed in May, 1892. It is on an elevation of Coasters Harbor Island, facing south, overlooking both the inner and the outer harbor, and is the most conspicuous object to be seen when entering Newport Harbor. The building is a three-story and basement, stone-faced structure, and houses not only the college but two sets of officers quarters at each end, these quarters being occupied by some of the members of the War College staff. In the college section of the building are a number of offices, chart rooms, the old library, and two

large rooms, one of the latter being used as the lecture and conference room and the other as the tactical war game room.

In June, 1904, a fire-proof annex was completed, furnishing additional offices, a vault for the archives of the college, and excellent new library rooms. But even including the annex, the work of the college is rather hampered for want of room during the summer conference.

Some of our most distinguished naval officers have in the past occupied the chair of president of the Naval War College, among them being Rear Admirals S. B. Luce, A. T. Mahan, H. C. Taylor, C. F. Goodrich, C. H. Stockton, F. E. Chadwick, C. S. Sperry, and R. P. Rodgers. Captain W. C. Rodgers has recently been detailed to and now occupies that position.

In 1900, when the General Board of the Navy was created, the president of the War College was made an ex-officio member of the board, and thus the college is brought into more or less intimate relations with the General Board. The relationship is something similar to, though not as close as, that of our General Staff and War College; our War College being a part of the General Staff. During the summer the General Board is located at the college which fact forms an additional bond, since the members of the General Board attend and take part in nearly all the conferences and discussions.

At present the staff of the War College consists of some eight officers in addition to the president and secretary. During the winter, or the season when the summer conference is not in session, the staff compile and put into final form the results of the conference of the preceding summer, outline and prepare the course for the following summer conference, and consider and report upon various matters referred by the General Board and the Navy Department. While the summer conference is in session the members of the staff act as directors of the work, deliver lectures, and act as umpires in the war games.

This year, for the first time, an attempt is being made to develop a so-called long course, and four officers have been detailed to take that course. The long course includes a series of tactical and strategical studies and problems the solutions of which are tried out on the game board, a course of reading, etc.

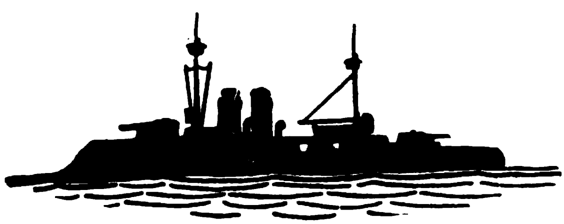
The work of the summer conference of 1911 included a number of lectures on current naval and military topics, strategy, international law, etc.; a series of map problems, if

they might be called such, involving studies of the theater in which was laid the great problem of the year; a series of map problems involving the issue of campaign orders; a large number of tactical war games; a number of international law situations, and also several tactical, strategical, and organization questions which were referred to committees for consideration and report; and finally the great problem of the year tested out by means of the strategic war game. The committee reports when submitted were considered by the conference as a whole, and both these reports and the solutions of the various map problems, brought out at times some interesting and enlightening discussions. By means of these discussions the army representatives obtained many excellent impressions of the Navy point of view.

I cannot close this short account without an acknowledgement of the many kindnesses and courtesies extended by both the staff and the members of the conference. We were given every facility for acquiring information and made to feel perfectly at home.

In conclusion I would emphasize the fact of the value of this course to coast artillery officers. We are interested in much the same gunnery problems as is the Navy, and though our methods may differ in many respects, in time of war our targets are the same, hostile ships, and each service has something to learn from the methods and point of view of the other. Since our main purpose as coast artillery in time of war is defense against hostile fleets, we can further our ends materially by an exchange of ideas with the officers of the navy, and by getting their point of view. I know of no better place to get that point of view than at the Naval War College,

Note:—For the facts relating to the history of the Naval War College, I am indebted to an excellent paper on that subject compiled by Captain H. S. Knapp, U. S. Navy, and on file in the Archives of the War College.



REPORT OF TESTS OF CENTRAL POWER PLANT*†

FORT WINFIELD SCOTT, CALIFORNIA

PER

G. O. 65, A. G. O., 1901

District of San Francisco,
OFFICE OF THE ARTILLERY ENGINEER,
Presidio of San Francisco, Cal.,
November 4, 1911.

BOILERS

Kind. Two (2), 200 H.P., Keeler, horizontal, water-tube.

Hydrostatic Test. Boilers, tubes, etc., as installed, were each subjected to 250 lbs. internal hydrostatic pressure. *Result:* No signs of leaks or weakness developed.

Capacity Test. The proper apparatus not being furnished, no evaporation test could be held to determine the horse power developed. There was no trouble experienced, however, in carrying approximately 200 engine horse power for 2 hours with either boiler, with comparatively smokeless combustion of the fuel.

Safety Valves. Two, 3½-inch Consolidated Safety Valve Co's, for each boiler, no releasing gear furnished with the plant for daily tests to prevent valves from sticking in their seats from long standing.
Action: Upon request, a releasing gear operated from the ground floor was installed by the Engineer Department.

Both safety valves on each boiler discharge into a single

* Published by authority of the Chief of Coast Artillery, in accordance with recommendation of the Coast Artillery Board.

† For illustrations and description of apparatus referred to, see article describing this plant, p. 14, Journal for July-August, 1911.

pipe, the cross sectional area of which is that of one valve alone. *Action:* Requisition submitted for a separate discharge pipe for each valve. This has just been received and will be installed at once.

CORROSION. After about two months run a slight roughness and pitting developed on the inner surface of the boilers along and above the water line. *Action:* Cleaned and coated with white zinc. No further corrosion has developed.

STEAMING. Average time required to raise 125 lbs. steam pressure from cold boilers, 2 hours. Steam could be raised in much less time, but owing to strains, warping, etc., due to too rapid changes of temperature the above is the usual time allowed in practice. There being no auxiliary boiler, "donkey boiler," for furnishing the initial steam required to atomize the fuel oil, in starting up, as is the custom in many commercial plants, it is necessary either to start up with wood fires, or to keep at least 20 lbs. of steam pressure at all times, to start the burners. The latter has been adopted for daily use. At first, it was necessary to steam up every 8 hours, which appeared to be excessive for this type and capacity of boiler. *Action:* Special attention was directed to securing tight fitting steam valves, dampers were adjusted, openings into furnaces and ashpits which admitted cold drafts were closed after shutting down, extra fire bricks were placed in the furnace for holding heat, and the lower part of the combustion chamber back of the bridge wall was filled with sand for the same purpose. *Result:* Steam can now be held 21 hours with sufficient pressure remaining for operating the burners, as shown by curves on blueprint enclosed herewith and marked "C."* These were made from data obtained by special tests and show that after 21 hours without firing, 20 lbs. pressure still remained. This method of steaming up is considered the most economical, the most handy, and subjects the tubes to least strains and warping due to cooling and heating.

GENERAL CONDITION. These appear to be good steaming boilers and are in excellent condition. Periodic cleanings of the boilers show no cracks, no pitting, no hard scale or corrosion, and no warping or bending of the tubes.

* Not reproduced herein.

OIL BURNERS*

(See blue print "F".)†

KIND. Two (2), W. N. Best, high-pressure, external-mixer.

OIL PRESSURE. 35 to 50 lbs. used.

STEAM PRESSURE FOR ATOMIZING THE OIL. Boiler pressure.

OPERATION. Owing to the high specific gravity of the fuel oil used (17 Baumé, or .9523 sp. gr.), it is first heated to 120°-150° F., to lower its viscosity and to assist in its atomization. This is done by means of steam coils in the reservoir of the oil-pumping apparatus. This burner is of the external-mixing type, *i.e.* the atomizing steam mixes with (and atomizes) the fuel-oil at the outlet of the burner. So far, however, its operation as a purely external mixer has not been successful. It has been found necessary to admit some steam into the oil pipe of the burner by means of the by-pass valve which was designed for use only in cleaning out this pipe after closing down the plant. In order that the oil may be atomized it must be forced out of the burner upward at right angles to, and through, the steam jet coming from the steam pipe. The admission of steam through the by-pass valve into the burner oil-pipe, further lowers the viscosity of the oil and greatly assists in forcing it upward through the steam for atomization. Having the burner in operation as above described, should the by-pass valve be then closed, the pressure in the oil pipe is so reduced that the oil is no longer projected upward through the steam, but flows out over the edges of the burner and downward on the fire-bricks below. Atomization therefore ceases, the flame is extinguished, and in a few moments the overflowing oil is re-ignited by the hot bricks and a "flareback" occurs. This is of sufficient force to blow the furnace doors open and may injure the fireman. This has been taken up with the manufacturers who claim it is the "only case on record" of its

* As a safety precaution, before starting the burner, it is important that the dampers and ashpit doors be opened and that the steam jet of the burner be turned on full force in order to expel any gas which may have accumulated in the furnace since last firing. Otherwise a "flare-back" may occur upon introduction of the burning waste used in starting the flame. (See pp. 48-49, Journal U. S. Artillery, July-August, 1911).
[This foot note was not a part of the original report].

† See foot note (†), on page 153.

kind and suggested a clogged oil supply pipe. *Action:* (1). The burners and pumps were disconnected and steam at 125 lbs. pressure was forced through the supply pipe, which was found to be free and open. (2). Next, in order to determine the oil pressure in the burner and in the oil supply pipe, and if found to be different in the two parts, to determine where the drop occurs, the following experiment was made: Pressure gauges were inserted (a) at the pump, (b) near the burner just below the oilfeed regulating valve, (c) above the regulating valve between same and the burner oil pipe, and (d) below the by-pass valve to indicate the steam pressure (1st column below).

The following pressures were obtained:

Pressures Obtained, Lbs. (Regulating Valve Open.)

Steam admitted through by-pass valve.	At oil pump.	Below regulating valve.	Between regulating valve and burner.
0	51	48	3
5	51	48	8
10	51	48	13
35	51	48	38

From the above it is seen that the oil pressure is reduced 3 lbs. (from 51 to 48 lbs.) per sq. in., in flowing through the supply pipe from the oil pump to the regulating valve just below the burner, and 45 lbs., (from 48 to 3 lbs.) in passing through the regulating (or feed) valve alone, leaving only 3 lbs. of the original 51 lbs. pressure at the burner.

It is also seen that whatever steam pressure is admitted through the by-pass valve (1st column) is added to the oil pressure in the burner (4th column) as was to be expected.

Conclusions. (1) That this burner and regulating valve which are of eastern make, were not designed for the heavy western oils; (2) that the oil pressure is throttled down by the regulating valve to such an extent that there is not sufficient pressure remaining in the burner for proper atomization; (3) that the introduction of steam through the by-pass valve again increases this pressure sufficiently for proper operation; (4) that although contrary to instructions published by the manufacturers, there is no objection from an economical or safety point of view to operating this burner as a semi-inside mixer; and (5) that its operation as such is satisfactory and

economical and accomplishes smokeless combustion of the fuel; at tests made to determine its economy it was found that power could be furnished at the switchboard at the rate of 1 K. W. hour per gallon of fuel oil burned, or about 1.5c per K. W. hour, when running on full load. This, however, does not include the cost of labor and incidentals.

OIL FEED PUMPS

KIND. Two (2), Blake, horizontal, duplex.

GENERAL CONDITION. Good. They have given entire satisfaction. The oil pressure to the burners can be readily regulated and the action of the pumps, after being once started, is entirely automatic. Self-contained heating coils, fed by the exhaust steam from the pumps enable the oil to be heated to any temperature desired for proper atomization.

BOILER FEED PUMPS

KIND. Two (2), Dow, horizontal, duplex.

GENERAL CONDITON. At present, good. At some time prior to, or shortly after, taking over the plant, some foreign particles, probably gravel, found their way into the water cylinders and scored the linings and pistons badly. *Action:* Requisition was submitted for new parts which were installed by the Engineer Department. *Precautions against similar damage in future:* The feed water is now habitually taken from a settling tank instead of from the mains directly, as was formerly done.

FEED WATER HEATER

KIND. One (1), Wainright, closed, water tube.

GENERAL CONDITION. Good. This has given entire satisfaction. Feedwater temperatures of 190° F. to 210° F., depending upon the load carried, are obtained. The temperatures of the feed water, as given on blueprints "A" and "B",* were taken by a thermometer bound to the outside of the feed-water pipe and are too low. Proper feed water thermometers have recently been installed. These record temperatures as given above.

STEAM PIPING

GENERAL CONDITION. Leaks: Several leaks developed at flanges soon after installation. *Action:* Attempted to

* Not reproduced herein.

tighten up on flange bolts but without effect. Examination of bolts showed they were set up to limit of threads. All were taken out and threaded further back by Engineer McDonald, C. A. C., in charge of the plant. Leaks stopped and no more have developed.

DRAINAGE. The steam headers were originally drained by means of an outlet pipe without trap. This was objectionable as the valve in this outlet pipe had to be left partially open at all times while running, causing a constant loss of steam. *Action:* Requisition was submitted for one steam trap for the headers and one for each steam separator. These were furnished by the Engineer Department and installed by the engineer in charge.

PLATFORMS. Upon request the Engineer Department has installed platforms along all steam piping, allowing inspections and repairs to be readily made.

LAGGING. Steam separators originally had no asbestos covering to prevent radiation of heat. *Action:* Supplied upon request by Engineer Department.

EXHAUST PIPING

LEAKS. A slight leak developed in this system near the floor on the vertical exhaust outlet, but was corrected by the engineer in charge.

GENERAL CONDITION. Good.

STORAGE TANKS

KIND. Steel. One (1), main storage tank and one (1), underground, 21,000 gallons and 1000 gallons, respectively.

GENERAL CONDITION. Good. No signs of leakage have developed.

ENGINES

KIND. Two (2), 195 H.P., Buffalo Forge, non-condensing.

HEAT TEST. The engines were run at full *generator* load until the temperature of the parts became practically constant, No. 1 set being so run for 4½ hours and No. 2 set for 4 hours. These runs were followed by a 2-hour 25% overload on the *generators*. In this connection it should be noted that this did not subject the engines to their guaranteed horse power, but

with the generator as installed no heavier load could be used in the test. The engines are rated as 195 H. P. at full load and 244 H. P. at 25% overload. The loads used (useful output) were equivalent to approximately 146 and 182 H. P. Evidently, from the memorandum of the acceptance shop test by the Engineer Department in October, 1909, these same loads were used by them. The following temperatures, therefore, while they do not indicate satisfactory running for the power for which the engines were designed, do show that the engines do not overheat with any load to which they may be subjected with the present installation.

Graphic records of the tests are given on blue prints enclosed herewith* and marked "A" and "B" for sets Nos. 1 and 2 respectively.

The rise of temperature of the various parts of the engines, above the average room temperature during the test, corrected by ½% for each degree C. of observed room temperature below 25° C. was found to be as follows:

1. Serial No. 12912. 2. Serial No. 12911.	Final Temp.		Actual Rise.		Corrected Rise.		Allowable Rise.	
Temperature, °C.	1.	2.	1.	2.	1.	2.	Specification.	A. S. M. E. Rules.
Engine bearing, left	45	52	26	31.3	24.4	32	55	55
Engine bearing, right	48	49.5	26.9	28.8	27.4	29.4	55	55
Crank bearing	48	49	26.9	28.3	27.4	28.9	55	55
Excentric strap	45	49.5	23.9	28.8	24.4	29.4	55	55
Oil in case	39	48	17.9	27.3	18.3	27.9	55	55

CYLINDERS. Upon taking charge of the plant the cylinders and valve bushing were examined. Both cylinders were badly scored, due to the presence of sand and grit. Further examination of the parts of steam chests showed the interior finish of the engines to be poor. Large patches of sand, apparently from original casting, were found throughout the ports, steam chests, and up near the trottle valves. This sand could be easily loosened with the finger. The Buffalo Forge representative claimed the scoring was due to sand and oil. This, however, could not be verified, but it was very clear that the

* Not reproduced herein.

sand could come from the interior of the engine itself as described above. *Action:* Both cylinders were re-bored and new piston furnished at the expense of the Buffalo Forge Co., and the sand fairly well removed. The cylinders are wearing well at present.

VALVES. The valve bushing on No. 1 engine (Serial No. 12912) was found to be cutting by one of the valve rings. *Action:* A new ring and bushing were finally installed on February 14, 1911, by the Buffalo Forge Co.

KNOCKS. Engine No. 1 (No. 12912) has developed a slight knock which we have been unable so far to remove. It appears to be in the valve chest and probably comes from a slight vibration of the bushing recently installed as above.

RACING. Both engines originally gave trouble from "racing" when running on no load. *Action:* This was remedied by the engineer in charge.

LUBRICATORS. The cylinder lubricators as originally installed were connected, above, to the lower fixture of the steam separator gauge glass. Its operation was satisfactory, but whenever a gauge glass blew out, the contents of the lubricators were forced out, spraying the engine, floor, and the engineer with oil. *Action:* Extra fittings were furnished by the Engineer Department and connection was made to the steam pipe above the separator, by the engineer in charge. No further trouble with the lubricators has been experienced.

OIL. The oil drip from the engines was formerly drained into a can on the floor beside the engines. *Action:* Upon requisition, the Engineer Department has furnished a tank, hand pump, and the necessary piping. The tank was installed under the engine room floor and the pump leading from it was placed beside the oil filter in the engine room. The installation was made by the engineer in charge.

FRICTION LOAD. This, as determined by indicator cards, is about 16 to 18 H.P., as claimed by the manufacturers.

REGULATION. Satisfactory. Speed, no load, 255; full load, 251 R.P.M. There is no "hunting" at sudden changes of load.

GENERATORS

KIND. Two (2), Western Electric, two-wire, D. C., 100 K.W.

HEAT TEST. The generators were subjected to the same heat run as mentioned above for the engines, viz., 4 to 4½

hours on full load to bring the parts to full load temperatures and 2 hours immediately following at 25% overload. Graphic record of the test is shown on blueprints "A" and "B" herewith.* All temperatures were taken by thermometer, and corrected, as for the engines, to 25° C., as standard. Final temperatures, observed rise, and corrected rise at the end of the overload-run were found to be as follows:

1. Serial No. 48125. 2. Serial No. 48126.	Final Temp.		Actual Rise.		Corrected Rise.		Allowable Rise.	
Temperature, °C.	1.	2.	1.	2.	1.	2.	Specification.	A. I. E. E. Rules.
Bearing, Outer	40	35	19	13.7	19.4	11	55	55
Frame	37	31	16	9.7	16.3	9.9	55	55
Series field	52	43	31	21.7	31.6	22.1	55	65
Shunt field	55	56	31	34.7	34.7	35.3	55	65
Brushes	100*	70	79 *	48.7	81.7*	49.6	55	70
Commutator	70	65.5	49	44.2	50	45	55	70
Armature	62.5	52	41.5	30.7	42.7	31.3	55	65
Room	21	21.3	—	—	—	—	—	—

*Limit of thermometer 100°, actual temperatures higher.

From the above it is seen that the brushes of No. 1 generator greatly exceeded the allowable temperatures. They probably reached 110° C., or more, but 100° being the limit of the thermometers, they had to be removed when that temperature was reached. The commutator did not heat as much as might have been expected, for the reason that the brushes were removed from time to time for cleaning, in attempting to reduce the temperatures. From the above data, the generators could not be considered as meeting the requirements of the specifications. *Action:* Every precaution possible was taken to reduce the sparking and heating, the vibration of the armature was reduced, the brushes were sandpapered carefully to fit the commutator, brush pressure was carefully regulated to one (1) pound per sq. in., as recommended by the manufacturers, the brushes were accurately spaced and adjusted to the neutral planes, etc., but without favorable results. The following trials were made on No. 1 set.

* Not reproduced herein.

Date.	Length of run.		Final temp. of brushes.	Remarks.
	Full load.	25% overload.		
February 8	30 Min.	25 Min.	98°C	The Brushes
February 8	30 Min.	45 Min.	100°C*	were refitted,
February 9	60 Min.	25 Min.	100°C*	cleaned,
February 9	30 Min.	15 Min.	100°C	adjusted, etc.,
February 10	30 Min.	15 Min.	100°C*	during and
February 10	25 Min.	20 Min.	98°C	after each
February 11	45 Min.	25 Min.	92°C	trial.
February 13	30 Min.	30 Min.	100°C*	Average room
February 24	20 Min.	10 Min.	96°C	temperature
February 24	———	15 Min.	100°C*	20°C.

*Limit of thermometer 100°, actual temperatures higher.

About this time the memorandum of the shop tests by the Engineer Department, was received. This showed that the same difficulty was experienced at the first test held by that Department and that the contractor asked to substitute the "Speer High Grade" carbon brushes made by the Speer Carbon Co., of St. Mary's, Pa. This was allowed and satisfactory results obtained.

A requisition was then submitted by this office for similar brushes and when received another heat test of the generators was made. The graphic record of this test is shown on blue prints "D" and "E" enclosed herewith* The final temperatures, etc., were as follows:

1. Serial No. 48125. 2. Serial No. 48126.	Final Temp.		Actual Rise.		Corrected Rise.		Allowable Rise.	
Temperature, °C.	1.	2.	1.	2.	1.	2.	Specification.	A. I. E. E. Rules.
Bearing, outer	40	37	13.9	9.4	13.8	9.3	55	55
Frame	40.5	39.5	14.4	11.9	14.3	11.8	55	55
Series field	61.5	51	35.4	23.4	35.2	23.1	55	65
Shunt field	61	66	34.9	38.4	34.7	37.9	55	65
Brushes, hottest	83	83	56.9	55.4	56.6	54.7	55	70
Brushes, average	76.5	74	50.4	46.4	50.1	45.8	55	70
Commutator	63	69	36.9	41.4	36.7	40.9	55	70
Armature	60	62	33.9	34.4	33.7	34.0	55	65
Armature clips	70	70	43.9	42.4	44.7	41.9	55	65
Room temperature	26.1	27.6	—	—	—	—	—	—

* Not reproduced herein.

As seen from the above, with these special brushes, no parts of the generator developed unduly high temperatures except No. 1 brush on No. 1 set, (see blue print "D"*) which during the last ten minutes of the run slightly exceeded the specification limit. An examination of this brush showed that it had collected enough copper, etc., from the commutator to cause it to exceed the limit by this small amount, viz. 1.6° C. Sharp angles in curve of brush No. 1, blue print "E,"* show the effects of collection of copper and dirt and its removal.

SPARKING TEST. During the first test, using the carbon brushes furnished with the plant, sparking could not be entirely eliminated at either full load, or overload, on No. 1 set (48125). With No. 2 set, sparking could be eliminated satisfactorily by shifting the brushes sufficiently for different loads. The amount of shifting required is practically the same for both generators, and amounts to about two and one-half segments of the commutator, or 5.7 degrees from 25% overload, to no load. This is more than should be required for a *modern* generator. There is no one position at which the brushes may be set and properly carry any and all loads within the above limits without undue sparking and consequent heating. The generators must be watched closely for change of load and the brushes set accordingly. While it is not probable that these generators will often be called upon to carry an overload, yet should such a load be thrown off with the brushes set at "overload" position, sparking at once becomes so violent that the brushes immediately become red hot. At full load it is not so violent, but sufficiently so to rapidly develop unduly high temperatures. With the special carbons referred to above, sparking was successfully eliminated on both generators by the same shifting of the brushes as required in the first tests.

PARALLEL OPERATION. Satisfactory.

GENERAL CONDITION. With the exception of the poor commutation they appear to be satisfactory and while they will undoubtedly do the work required of them, they will require close watching and the use of the special high grade carbon brushes.

CURRENT REQUIRED. Several trials were made to determine the maximum current required at all batteries, position-finding stations, etc. All lights were burning and at a prearranged signal all hoist and retraction motors were started.

* Not reproduced herein.

At no time did the current exceed 400 amperes, which is less than full load on one generator.

SWITCHBOARD

KIND. Two (2), generator, and two (2), feeder, panels.

GENERAL CONDITION. Good. Has given entire satisfaction.

WIRING

INSTALLATION. In underground conduits.

INSULATION. Satisfactory. The "grounds" of the system are negligible, except that occasionally they develop in the emplacement wiring at the batteries, but are readily removed.

Respectfully submitted,

J. C. JOHNSON,
Captain, Coast Artillery Corps,
District Artillery Engineer.

Note. As indicated on page 45, JOURNAL U. S. ARTILLERY, issue of July-August, 1911, no test of the plant as a whole after completion was required by specifications. No fittings, valves, etc., were supplied by the Engineer Department for such a test. The plant therefore as installed and turned over by the Engineer Department could not be properly tested for capacity, efficiency, and economy. It would appear wise that the specifications should be so changed in the future as to provide with the original installation such equipment and accessories as would be required for such a test. (This note was not a part of the original report.)

A PROPOSED SYSTEM OF TARGET PRACTICE FOR HEAVY GUNS

By Captain JOHN L. ROBERTS, Jr., Coast Artillery Corps

The writer has long been of the opinion that rapidity of fire is given undue prominence in target practice, and even in action while hits per minute may well indicate the efficiency of the battery, misses per minute must also be considered, and it is held by many that a battery firing one shot per minute will, during a "run past," make more hits than one firing much faster. That this matter has not escaped the notice of the War Department is shown by the following extracts from "Technical Notes and Extracts from Records of Coast Artillery Practice for 1910."

> "In Coast Artillery Memorandum No. 6, War Department, 1909, attention was called to the fact that in target practice, accuracy should be attained before speed. It is thought that all officers realize this, yet in the heat of competition this important consideration is lost sight of, and in many practices ammunition is thrown away because the operations connected with laying and firing are done with too great haste " * * " The attainment of accuracy and safety precautions should be the first consideration in target practice."

As long as companies are graded on the figure of merit basis, competition is bound to be keen and when, as at present, the time factor enters very largely into the calculation of this figure of merit, speed must be attained at the expense of accuracy.

Rapid loading and tripping may be taught and practiced with dummy ammunition, and by using powder charges made up of cylindrical pieces of wood of the size and shape of powder grains, service conditions may be very nearly approached.

Target practice should be considered a practical drill having for its object the instruction of the personnel. It should be conducted deliberately so that the errors made in one shot can be corrected in the next, since as much may often be learned from a miss as from a hit. The score should be a secondary consideration and accuracy attained by eliminating errors in succeeding shots. The trial shots were instituted

for this purpose, but it often happens that even after firing three shots at a fixed target, the muzzle velocity for the record shots can not be predicted with any degree of confidence, and if these are fired using unsatisfactory data, the ammunition is little better than wasted.

Assuming then that the present method is not entirely satisfactory, how can it be improved? Obviously in two ways: By increasing the number of trial shots at the fixed target, or by firing the record shots with more care. The first proposition only partially overcomes the objections to the present system and is practically out of the question, owing to the small allowance of ammunition, the latter alternative presents a wider field for experiment.

In order to remedy the defects in the present system above referred to, the following method of conducting target practice for 8-, 10-, and 12-inch guns is suggested. It is assumed that the allowance of ammunition will provide for an expenditure of seven rounds in the first practice and nine in the second.

The annual target practice shall be divided into two parts, instruction practice and record practice. No company failing to make one hit in the last four shots of instruction practice shall be permitted to hold record practice, but shall be required to repeat the instruction course at the time record practice would ordinarily be held, provided however that the allowance of ammunition shall be that for record (second) practice.

Instruction Practice.—A buoy to be known as the starting buoy is permanently anchored at one end of the course to be run by the tug and if possible about 6000 yards from the battery firing. In locating this buoy the depth of water, strength and set of tide, probability of interference by shipping, observing angles, etc., etc., will be considered and the most favorable point selected. The course from the starting buoy may be run by ranges on shore, or another buoy anchored to to mark the further end. It need not be long and smaller buoys having flags attached may, if desired, be placed between the two buoys marking the ends. The starting buoy and range marks are accurately plotted on the plotting boards of the battery firing and at least one other. All shots shall be fired at a moving target, but with deliberation, the object being to locate, and as far as possible correct, all errors. The first three shots will ordinarily be fired with the same assumed muzzle velocity, unless in the opinion of the battery commander the range error is excessive. The fourth, or any succeeding

shot, being a hit, the remaining shots will ordinarily be fired from the other guns of the battery,—this to determine, if possible, the individual firing error of each gun. Exceptions to this rule may be made, if in the opinion of the battery commander there was anything abnormal about the hit and the reasons for such exceptions will be fully set forth in the report of target practice.

The tug with the material target takes up a position that will enable the tow line to be stretched, and the proper speed attained when the target passes the starting buoy. When the battery commander is ready, the tug is signaled to start, tracking begins, corrections are made and the piece is loaded and fired as soon as possible after the target has passed the starting buoy. The battery commander assures himself of the correctness of the data furnished to the guns before firing. Should it become evident that the shot cannot be satisfactorily fired before the tug finishes the indicated course, it may be signaled to return to the starting buoy. If the shot is fired, the tug signals the over or short as shown by the range rake, returns to its first position and prepares to run the course again on signal. The position of the target at the moment of splash is taken by another base line, and its position located on the plotting board of the battery firing, by means of rectangular coordinates having their origin at the starting buoy.

The deviation of each shot from the center of the target is determined as at present by a deflection observer on shore and, together with all other data, should be available for use by the battery commander a few minutes after each shot is fired.

Record Practice.—To be conducted as now prescribed for second practice; at short range, 5000 to 6000 yards, for batteries making two hits or less, and long range, minimum of 8000 yards, for those making three or more hits in the last four shots of instruction practice.

As only one shot is fired on each run of the tug in instruction practice there would be little or no excuse for the personnel to get rattled after firing one or two shots, and the setting of all instruments can be checked each time the gun is fired.

At small expense a sight standard and sight could be attached to the carriage on the side opposite the gun pointer and an extra man stationed there with instructions to keep the cross hair constantly on the target, and by noting the deflection at the moment of firing, errors in aiming would be dis-

covered. Seven shots fired in this manner would give the fire control section more practical work than the same number of shots fired under the present system, and unknown errors would be reduced to those of projectile flight, functioning of the carriage and irregularity of powder. The report of the board conducting experiments concerning the accuracy of fire published in the ARTILLERY JOURNAL of September-October, 1911, pp. 156 *et seq.*, states that the two former are insignificant, leaving the powder to be charged with any erratic shooting not otherwise accounted for. Instruction practice as outlined above would be a valuable adjunct to calibration firing, in fact the records of such practice might be of even more value to a battery commander than the report of a calibration board.

COAST DEFENSE IN THE CIVIL WAR*

FORT SUMTER, CHARLESTON, S. C.

(First Attack)

By 1st Lt. J. L. HOLCOMBE and 1st Lt. W. J. BUTTGENBACH, C. A. C.

GENERAL SITUATION

On December 20th, 1860, South Carolina through the action of the State Convention meeting at Charleston, passed an Ordnance of Secession, thus seceding from the United States.

On Dec. 26th, 1860, Major R. Anderson, 1st U. S. Artillery, who was in command of U. S. troops in Charleston Harbor, transferred his forces to Fort Sumter and abandoned Fort Moultrie. He considered Fort Sumter could be better held and was a more important work and was besides "storm free" which Fort Moultrie was not. (For general location of forts, see Fig. 1.)

On December 27th Castle Pinckney and Fort Moultrie were seized by the authorities of the State of South Carolina, and on the 30th the Federal Arsenal in Charleston was taken. On January 2, 1861, Fort Johnson was seized by State authorities.

On January 5, 1861, the "Star of the West" expedition with stores, recruits, etc., left New York harbor to reinforce the garrison in Charleston harbor, arriving off said harbor

* This is the first of a series of papers on the Coast Defense Operations of the Civil War. They are not intended as a history of the War. Other military operations will be but sketched in.

It is hoped that these studies will serve to bring out certain phases of sea coast warfare that seem to be but scantily treated in the usual histories. The data covering these papers are taken mostly (in some places word for word) from the Official Records of the Union and Confederate Armies and Navies in the War of the Rebellion.

It is hoped that these papers may serve to interest others in the work of these artillery men who manned their guns during a war lasting four years, and although artillery weapons and their accessories have been much improved, yet it is thought the work done by them may yet be of value and show that some things are not "so different now."

January 9th. But the ship "Star of the West" was fired upon, was struck several times by some of the channel batteries that were manned by the Confederate, or rather State, forces, and was driven back, finding it impossible to come into the harbor. Fort Sumter did not return the fire of batteries firing and the "Star of the West" returned to New York, her mission a failure. This might be looked upon as the first hostile action on the part of a seceding state against the United States, defying the Federal authorities by preventing a landing of stores and men in a United States garrison.

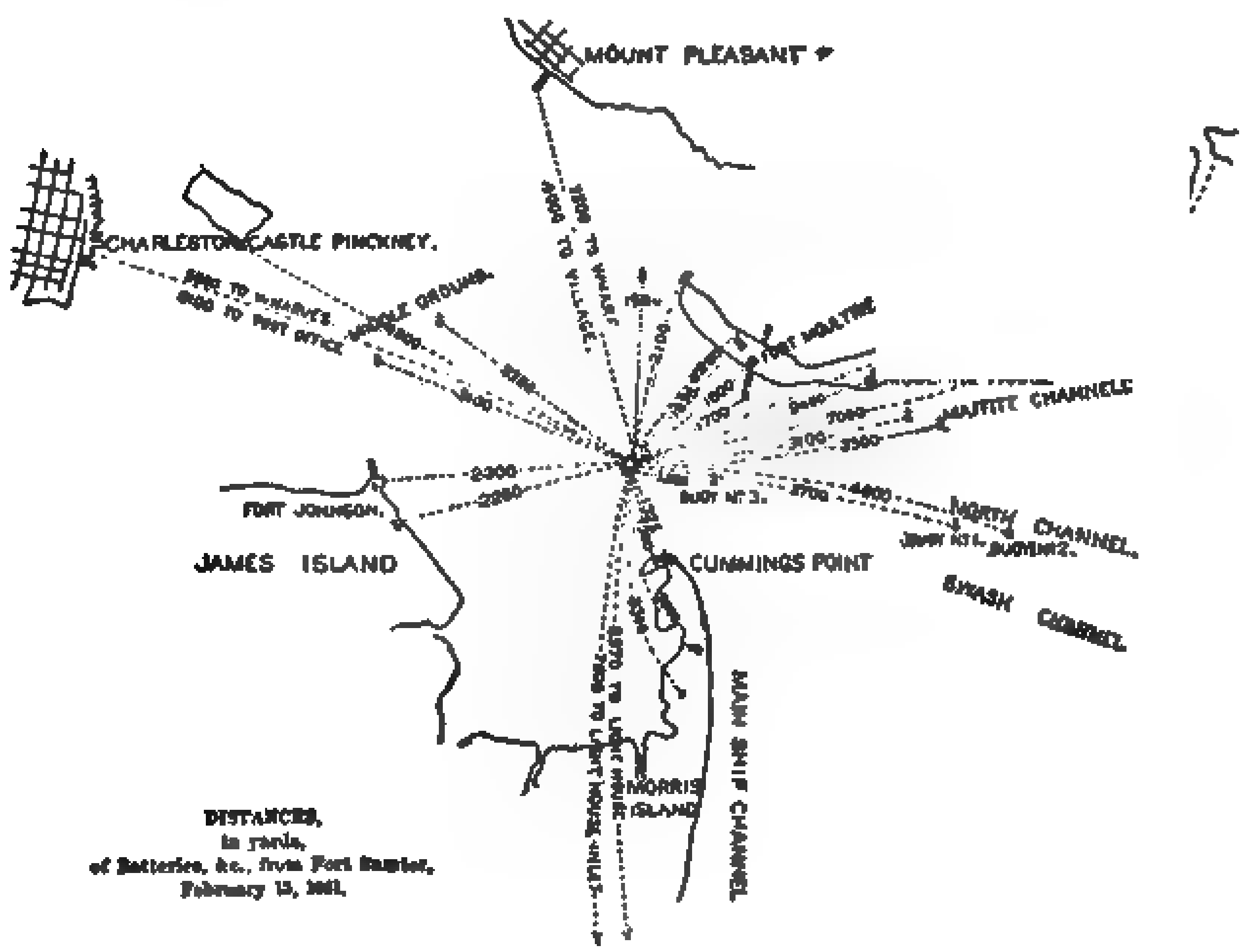


FIG. 1.

Sketch of Charleston Harbor, from Official Records of the Union and Confederate Armies, Vol. I, p. 174.

On January 11th, 1861, a demand for the surrender of Fort Sumter was made by Governor Pickens of South Carolina, for and in behalf of the state. This was refused by Major Anderson. Political tension increased in Charleston and it was demanded that the Federal authorities make no attempt to reinforce, or supply, the garrison of Fort Sumter. The

Federal Administration let matters drift, as a new Administration, "Republican," was to succeed in March, Lincoln having been elected President. Fort Sumter by permission of Governor Pickens and local authorities was allowed to receive subsistence stores, mail, etc., from Charleston.

On March 3rd Brigadier General G. T. Beauregard, Confederate Army, assumed command of all military forces at Charleston and on April 11th, acting under orders of the Confederate authorities, he demanded the evacuation of Fort Sumter. This was refused.

SPECIAL SITUATION

It was learned in Charleston, that another attempt would be made to reinforce Fort Sumter, by a joint Army and Navy expedition, leaving New York harbor the early part of April. It was to consist of three ships of war with 200 men and a year's supply for the garrison. They were accompanied by three tugs to aid in landing. This expedition, ordered by President Lincoln, was ready to sail April 6th, and its orders covered the following points:—

1st. To deliver the subsistence stores to Fort Sumter.

2nd. If resisted, to force a landing under cover of the navy.

Thus, expecting that Fort Sumter was to be reinforced, or a descent made upon the coast, it was considered an imperative necessity on the part of the Confederate authorities to reduce the fort as soon as possible, and not to wait until the ships could aid the fort. On Major Anderson's refusal to evacuate the fort, he was given notice that the bombardment would commence on April 12th, 1861.

OPPOSING FORCES

Works.—

Fort Sumter consists of a partially finished, 5-sided, closed work, of masonry construction, having four faces and a gorge. It was intended to mount 3 tiers of guns, *i.e.*, 2 tiers casemate and 1 tier barbette, but the second tier could not be mounted at this time, due to incomplete condition of work. Walls were four and a half feet thick, about fifty feet high; gorge was about 360 feet long, two flank faces about 170 feet and two front faces about 200 feet. (Fig. 2.)

The barbette tier had the following armament:

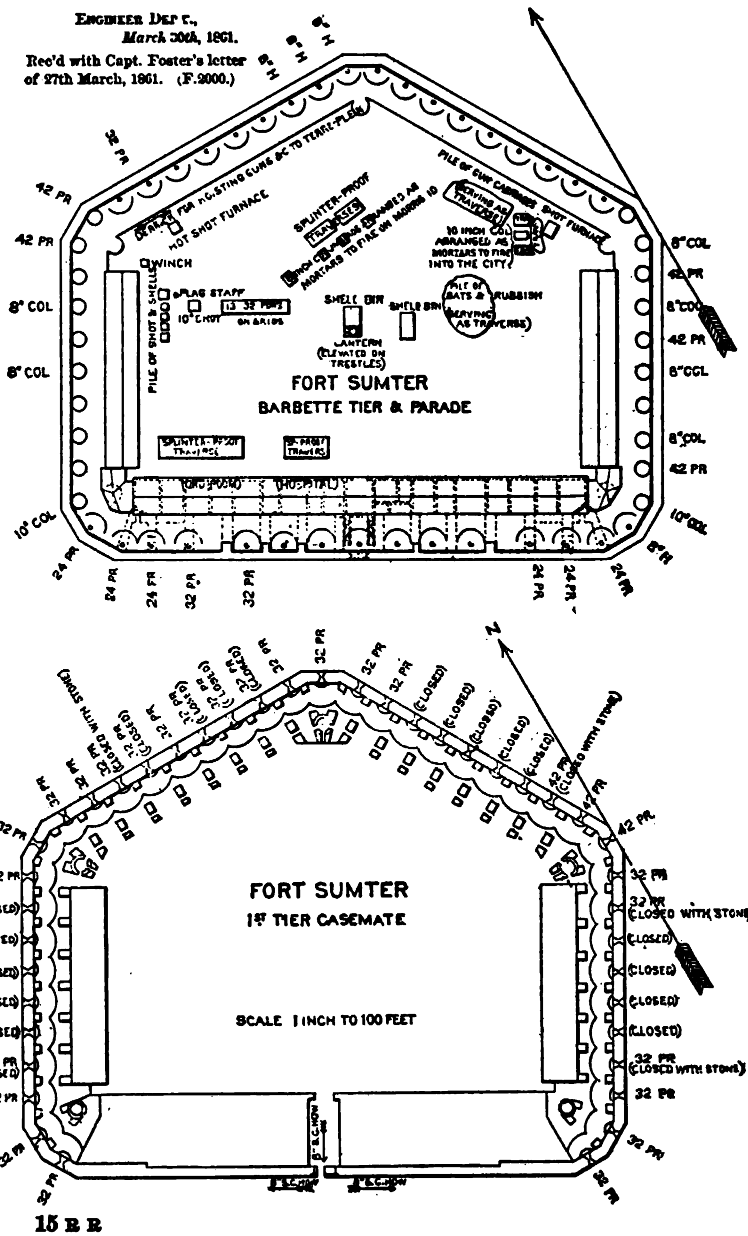


FIG. 2.

From Official Record of the Union and Confederate Armies, Vol. I, p. 225.

Right flank.—
1, 10-inch columbiad.
4, 8-inch columbiads.
4, 42-pounders.
Right face.—None.
Left face.—
3, 8-inch, sea-coast howitzers.
1, 32-pounder.
Left flank.—
1, 10-inch columbiad.
2, 8-inch columbiads.
2, 42-pounders.
Gorge.—
1, 8-inch sea-coast howitzer.
2, 32-pounders.
6, 24-pounders.
Total in barbette tier, 27 guns.
The casemate tier had the following armament:
Right flank.—
1, 42-pounder.
4, 32-pounders.
Right face.—
3, 42-pounders.
Left face.—
10, 32-pounders.
Left flank.—
5, 32-pounders.
Gorge.—
2, 32-pounders.

Total in casemate tier, 21 guns available, and in both tiers, 48 guns.

On parade ground there were arranged to serve as mortars:
1, 10-inch columbiad
to throw shells into Charleston, and
4, 8-inch columbiads
to throw shells into the batteries on Cumming's Point.

The casemate guns were the only ones used. Those of this tier that bore on Cumming's Point were the 32-pounder in the *pan coupe* of the right gorge angle, the 32-pounder next to it on the gorge, which had been made to traverse sufficiently by cutting into the brick wall of the work; and the 32-pounder next the angle on the right flank had been made to bear on a portion

of the Point by cutting away the embrasure, although not bearing on the breaching batteries.

The guns of this tier that bore on Fort Johnson were four 32-pounders on the left flank (of these one embrasure had by order been bricked up). The guns that bore on the batteries on the west end of Sullivan's Island were 10, 32-pounders (nine situated on the left face and one at the *pan coupe* of the salient angle, though five of these embrasures had been bricked up).

The guns bearing on Fort Moultrie were 2, 42-pounders situated on the right face, and 1, 42-pounder at the *pan coupe* of the right shoulder angle.

Ammunition Supply.—

The supply of powder was ample, being some 40,000 lbs. and of shot there were ample. Supply of shell, primers, and cartridge-bags was extremely limited—on April 11th, 700 cartridges were reported ready. The work of making cartridge bags was very slow, there being but six sewing-needles in the fort and a great lack of material. Sheets, blankets, clothing, stockings, etc., some of which even belonged to members of the garrison, were used for making cartridge-bags.

Fire Direction.—

The only instruments available in the fort for use with guns, were one gunner's level, two quadrants, and some tangent sights.

Captain Chester in his article in "Battles and Leaders of the Civil War", mentions some of the following devices used during the bombardment, which were said to have given satisfactory service, although the targets by reason of smoke, or darkness, could not be seen:—

The guns had sight lines to prominent objects marked on the traverse circles, thus giving definite lines of direction to certain targets.

Elevations were secured as follows:—

Ranges were obtained from Coast Survey Harbor Charts and the corresponding elevations computed from range tables. Elevations were given by quadrant angles, brass rods were fastened to the cheeks of the chassis and a horizontal white line, the projection of the axis of the piece through the trunnions, was painted on each gun. The point where this white line cut the brass rod, was marked with a chisel and the initials of the object on which the gun was laid, thus getting the proper elevation for known targets.

Garrison.—

9 officers,

76 men,

43 civilian employees, Engineer Department.

Barracks.—

There were two barrack buildings, one occupied as officers' quarters, made of brick, intended to be fire proof, having iron cisterns on the roof. Besides these there were some temporary sheds, which were, however, burnt up for fuel.

Stores.—

On March 21st, there were on hand the following:

6 barrels	flour,	26	barrels pork,
6 "	hardbread,	¼	barrel salt,
3 "	sugar,	1½	barrel rice,
1 "	coffee,	3	boxes candles.
2 "	vinegar,		

MEASURES OF DEFENSE

Owing to the limited number of the garrison there were apprehensions of an assault. Hence, many embrasures on the lower tier were bricked up. The gate was almost entirely closed, the wharf was mined, fougasses were arranged on the esplanade, machicoulis galleries placed to sweep the rip-raps at the base of the fort; hand grenades were made by filling hollow spherical shell and plugging with a friction primer, to which was attached a rope, so they could be thrown over the wall, and when so thrown were exploded. Barrels filled with stone and with explosive charges in the center, to be fired by same device (thunder barrels) stood about the work.

SULLIVAN'S ISLAND

Works.—

Fort Moultrie.

Fort Moultrie (Fig. 3) was a small formal work of irregular trace intended to mount barbette guns only, but the Confedates by the erection of a glacis, merlons and bomb-proofs had practically converted it into an earth work with casemated guns.

This work had been abandoned in December by the Federal forces and immediately taken possession of by the Confederates, who expended on it much time and labor, adding materially to its defensive character.

Other works on Sullivan's Island were field works of more or less permanent character.

Fort Moultrie had in all some 30 guns, being mostly 24-, 32-, and 64-pounders and including

3, 8-inch columbiads,
2, 8-inch seacoast howitzers.
5, 32-pounders.
4, 24-pounders.

Mortar Battery No. 1,

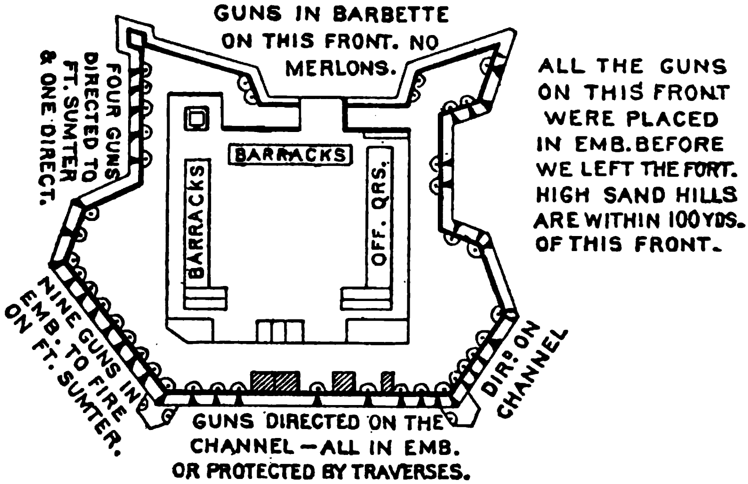


FIG. 3.

Fort Moultrie. From Official Records of the Union and Confederate Armies, Vol. I, p. 146.

2, 10-inch mortars.

Enfilade Battery,

2, 24-pounders,
2, 32-pounders.

Point Battery,

1, 9-inch Dahlgren.

Five-gun battery east of Fort Moultrie.

Maffit Channel battery,

2 guns.

Mortar Battery No. 2,

2, 10-inch mortars.

Floating Iron Clad Battery,

2, 42-pounders,
2, 32-pounders.

This battery was built on a raft, or float, with guns in casemates, the upper works being of railroad iron and earth. It was towed to a definite position and anchored. This was a very ingenious use of a floating battery to supplement shore defenses.

Mount Pleasant Battery (situated on main land, part of the Sullivan's Island Command),

2, 10-inch mortars.

Of these guns, there bore on Fort Sumter the following:—

3, 8-inch columbiads, 2, 32-pounders, 6, 24-pounders,	In Fort Moultrie.
2, 24-pounders, 2, 32-pounders,	Enfilade Battery.
1, 9-inch Dahlgren, 2, 32-pounders, 2, 42-pounders, 6, 10-inch mortars.	Point Battery.

There were also the following:—

Morris Island:—

Cumming's Point Battery,
Blakely Rifled Gun Battery,
Breaching Battery No. 1,
2, 42-pounders,
Mortar Battery,
3, 10-inch mortars,
Stevens Iron Clad Battery (Breaching Battery No. 2),
3, 8-inch columbiads,
Trapier Battery (next to No. 2),
3, 10-inch mortars.

The garrison of Morris Island was about 500 men.

James Island:—

Battery at Fort Johnson,
3, 24-pounders (only one bearing on Fort Sumter),
Mortar Battery south of Fort Johnson,
4, 10-inch mortars.

The garrison of James Island was about 200 men.

Thus of all guns, there were bearing on Fort Sumter
30 guns,
17 mortars.

The Confederates seemed to have an ample supply of ammunition, etc., and were anxious to get into action against Fort Sumter.

Garrison.—

The garrison manning these works was about 800 men, although there were many more Confederate troops in their neighborhood.

NARRATIVE OF EVENTS

On April 12th, 1861, at 3:30 a.m., notice was served on Major Anderson by the Confederates that their batteries would open fire in one hour. At 4:30 a.m. a signal shell was fired from a battery on James Island, then the Mount Pleasant mortars opened and the firing soon became general from all the hostile batteries.

At 7 a.m. the guns on Fort Sumter replied. The first shots were fired from the battery at the right gorge, using only 32-pounders and 42-pounders of the lower tier. All officers and men were divided into 3 reliefs of two hours each.

The supply of cartridges, 700 in number, with which the engagement had commenced, became so much reduced by the middle of the day, that the firing had to slacken materially and was confined to six guns, two firing toward Morris Island, two toward Fort Moultrie, and two toward the batteries on the west end of Sullivan's Island. The fire of Fort Sumter continued steadily till dark.

The effect of the fire, however, was not very good, owing to the insufficient caliber of the guns for long range. Not much damage appeared to be done to any batteries except those at Fort Moultrie, where the Fort Sumter 42-pounders appeared to have silenced one gun and to have injured the embrasures considerably, riddled the barracks and quarters and torn three holes through the flag flying there. The so-called "Floating Battery" was struck very frequently by the fire from Fort Sumter, one shot striking at the angle between the front and roof, penetrated entirely through the iron and wood work beneath and wounded one man. The rest of the fort 32-pounders failed to penetrate the front, or roof. The projectiles were deflected from their surfaces, which were arranged at a suitable angle to accomplish this. The Dahlgren Battery near the Floating Battery did not appear to be much injured. Only one or two shots were fired at Fort Johnson and none at Castle Pinckney, or on the city.

The fire toward Morris Island was mainly directed at Stevens Iron Clad battery, but the small caliber of the shot failed to penetrate the covering when struck fairly. Aim was,

therefore, taken at the embrasures which were struck twice, disabling the guns, it was thought for a time. Shot were seen to bounce off repeatedly from the Iron Clad battery. It was also seen that the shooting against Fort Moultrie was good, but it presented a poor target. The embrasures were repeatedly struck and the gunners thought they had dismounted guns there. As a matter of fact, the shot failed to penetrate, as the embrasures were stopped with cotton bales against which solid shot was ineffective. These might have been destroyed if shell had been available. One or two shot were thrown at the reverse of batteries No. 3 and No. 4, scattering some groups of officers and men on the lookout and also cutting down a small flag at one of the batteries.

The effect of the Confederate fire on Fort Sumter was very great. The barracks were set on fire three times the first day, but the flames were extinguished. Vertical fire was especially effective. From the 17, 10-inch mortars firing, one-half of the shell came within, or exploded above the parapet of the fort. About ten buried themselves in the soft earth of the parade without exploding. Consequently, Major Anderson decided not to man the upper tier of guns, as the loss of the men would have been too great. These guns were fired but once, or twice, producing no effect. The enemy's shells came from the north-east, north, south-west and south-east, searching out every part of the work. The fuzes were well graduated, exploding, in most instances, just within the parapet. To this kind of fire no return was made. Neither the four, 8-inch columbiads, nor the 10-inch columbiads planted on the parade were used, to fire towards the city. The hot-shot furnaces were not opened, or used. The effect of the direct fire from the Confederate guns was not so marked as the vertical. For several hours from the commencement of the bombardment, a large proportion of their shots missed the fort. But their aim subsequently improved, doing damage to the roof and upper story of the barracks and quarters and to the tops of the chimneys and the gorge. The object of the gunners during the day, with the exception of batteries No. 1 and No. 2 on Cumming's Point, appeared to be to dismount the guns of our barbette tier. Those from Fort Moultrie succeeded in dismounting an 8-inch columbiad and in striking on its side and cracking a second 8-inch columbiad, both situated on the right flank. The roof of the barracks on this flank and the stair towers were much damaged by this fire.

The shots from the guns in the batteries on the west end of Sullivan's Island did not produce any considerable direct effect, but many of them took the gorge in reverse and, so great was their angle of fall, completely riddled the officers' quarters, even down to the first story.

Three of the iron cisterns were destroyed and the quarters below flooded. The shots from these batteries and from Fort Moultrie aimed at the embrasures failed to produce any effect. None of the shots came through, although one shell exploded in the mouth of the embrasure.

A part of the guns from Cumming's Point tried to dismount the barbette tier on the gorge, the remainder to breach the gorge or rather the *pan coupe* at the right gorge angle. At this latter point, two columbiads and a Blakely rifled gun fired almost constantly. The effect of this fire on this day was to breech around the embrasures of the first tier at the *pan coupe* to a depth of twenty inches and to put one shot through the filling, consisting of brick and blue stone combined, with which the embrasure openings of the second tier had been filled. One shot was also put through the top of a loop hole window on the second tier, another through the top of the main gate and a third through a magazine ventilator at the right of the gorge, falling between the pier and the inner wooden ceiling. Three embrasure cheek-irons on second tier loop-holes were knocked out of place. Several stones that had been placed in the first tier loop-holes were struck, but owing to the lead run in around them, to hold them in place, none were broken.

Penetration of the 8-inch columbiad from Cumming's Point was eleven inches at the first shot, and that of the 12-pound projectile from the Blakely gun measured the same; the latter threw its shot with greater accuracy and with less time of flight. The distance was about 1250 yards.

Shot from Cumming's Point that passed a little over the gorge took the left face in reverse damaging masonry of parade wall, coping, etc., splintering chassis of one barbette gun. Showing strength of masonry, a 10-inch shell from Cumming's Point fell upon the second tier casemate arch, which was covered by concrete, or flagging. The shell did not penetrate this 15-inch arch, but merely embedded itself and caused some brick work to break off below.

The night was stormy with a high wind and tide. Personal inspection showed that the exterior of the work was not damaged to any extent.

The Confederates threw shells every ten or fifteen minutes during the night. The work of making cartridge bags was continued till midnight, when it was stopped by order of Major Anderson. To obtain material for bags, all extra clothing of the companies was cut up and all coarse paper and extra hospital sheets were used.

On April 13th at daybreak, no material alteration was observed in the enemy's batteries. The last of the rice was served at breakfast, with pork, the only other article of food left. After this, fire reopened and continued very briskly as long as the increased supply of cartridges lasted. The Confederates opened fire at daylight and continued it with rapidity. The aim of the Confederate gunners was better than on the previous day. One shot from the rifled gun in the battery at Cumming's Point struck the cheek of the embrasure in the right gorge angle and sent a number of large fragments inside, wounding a sergeant and three men. A spent ball also came in with the fragments.

An engineer employee was wounded by a piece of shell which burst inside the fort close to the casemates. One or two balls also penetrated the filling of the embrasure openings on second tier but fell inside, entirely spent. One of them set a man's bed on fire. It soon became evident that the enemy was firing hot shot, especially from Fort Moultrie. At nine o'clock that morning, the officers quarters' where shot had just penetrated, were on fire and burning. Due to the exposed position it was impossible to extinguish the flames and the Commanding Officer was so notified. Permission was given to remove as much powder as possible from the magazine before the flames, which were then only one set of quarters distant, should encircle the magazine and make ir necessary to close it. Men worked rapidly, but so quick was the spread of flames that only fifty barrels could be taken out and moved to other casemates before the heat made it necessary to close the doors of the magazine and pile earth against them. As soon as the smoke and flames burst from the roof of the quarters, the Confederate batteries redoubled the rapidity of their fire, using red hot shot from most of their batteries. The whole range of officers quarters were soon in flames. The wind was from the southward and fire was communicated to the roofs of the barracks, so that by twelve o'clock all the woodwork of the quarters and the upper story of the barracks were in flames. All the wooden part of the west barracks was burned and it

required hard exertions to keep the flames from burning all the woodwork of the east barracks and down to the lower story where the garrison had now taken refuge. Smoke and cinders flew into the casemates, setting fire to boxes, beds, etc., making it dangerous to keep powder there. The Commanding Officer gave orders to have all but five barrels thrown out of the embrasures into the water. This was done, but the barrels collected on the rip-rap, where it was exploded by the hostile fire, blowing a gun out of the embrasure.

The small stock of cartridges now on hand allowed a gun to be fired but every ten minutes. The flagstaff was struck several times that day. At 1 P.M., the flagstaff was struck again, and fell. The flag was, as soon as possible, hoisted on the parapet. About this time it was reported that Mr. Wigfall bearing a white flag was on the outside of the fort and had come from Cumming's Point. He asked to see the Commanding Officer, saying he came from General Beauregard. As the flag was shot down, fire raging in the quarters and the garrison in sore straits, he proposed that hostilities be suspended and the white flag raised. He was told that the flag had been raised again, but Major Anderson met him and asked him what terms he had to offer. It was found that Wigfall had no authority from General Beauregard and action was to be recommenced, when some staff officers came direct from General Beauregard to the fort and proposed terms which were accepted by Major Anderson. These terms were that he should evacuate the fort, taking arms and all private and company property; that he should salute the flag, as it was lowered; and that he and his command should be conveyed, if he desired, to any northern port.

Upon this understanding, the flag was lowered and the white flag raised, thus ending the bombardment after a defense of thirty-four hours. There were no supplies on hand, except four barrels of pork, and only three cartridges of powder available. There was powder in the magazines but it could not be gotten at.

On April 14th the Federal command, after saluting the colors, was withdrawn and on April 17th, arrived in New York harbor.

During the bombardment three United States vessels arrived, and another came at 2 P.M. the day of the surrender. These vessels had been sent from New York for the purpose of relieving the fort, bringing a year's supplies and 200 recruits.

This expedition failed, however, as the naval vessel, the Powhatan having the orders for the movement, as well as the launches and sailors, was detached from the expedition, without the knowledge of the Navy Department, and sent to Fort Pickens. This was by virtue of *carte blanche* instructions issued to General Meigs and Commander Porter by President Lincoln. The remaining vessels considered themselves too weak to attempt anything.

Captain Foster, Corps of Engineers, who was present in Fort Sumter during the action made some interesting comments. Among other things, he says:

"Fire on the second day, directed toward embrasures, more rapid and more accurate, set buildings on fire. Only two embrasures were struck, attempt to form a breach at the the right gorge angle did not succeed, succeeded only in breaking around one embrasure some 22 inches deep without disabling a gun or rendering embrasure inefficient, barbette tier was not much injured by the second day's firing, none of the guns were dismounted and few were struck. The fire, however, destroyed all the gun carriages and splinter proofs on the gorge. After cessation of fire about 600 shot marks on the face of scarp wall were counted, but were so scattered that no breached effect could be expected from such fire and probably none attempted, except at the right gorge angle. Only effect of direct fire during the two days was to disable three barbette guns, knock off large portions of the chimneys and brick walls projecting above the parapet and to set quarters on fire with hot shot. The vertical fire produced more effect, preventing working of the upper tier of guns which were really the only effective guns in the fort, being columbiads, 8-inch sea coast howitzers and 42-pounders principally. It also prevented use of columbiads arranged on the parade to be used as mortars against Cumming's Point. The shells that struck the stair towers nearly destroyed them, filling stairways with much rubbish. This, with the destruction of the stairs at the gorge by the explosion of the magazine of shells by fire, made it almost impossible to get the *terre plein*.

"Burning of quarters produced great effect, as heat and smoke were almost stifling, fire burned all around the magazines, obliging us to close them and preventing us from getting powder to continue firing. It also destroyed main gates and gun carriages and parapet of the gorge, but we could have resumed firing as soon as walls cooled sufficiently to open

magazines. Then we could have blown down the wall, which was left projecting above the parapet, so as to get rid of the flying brick, and built up the main gates with stones and rubbish. The fort would actually have been in a more defensive condition than when the action commenced. In fact, it would have been better if the chimneys, roofs, upper walls of quarters and barracks had been removed before the action had begun, but the short notice and small force did not permit it after the firing had commenced.

"Weakness of defense principally lay in lack of cartridge-bags and of material to make them, by which our fire was at all times rendered slow, and, towards the last, was nearly suspended.

"Lack of a sufficient number of men to man the barbette tier of guns, at risk of losing several by heavy vertical fire of the enemy, also prevented us from making use of the only guns, that had power to smash his iron-clad batteries, or of throwing shells into his open batteries so as to destroy his cannonneers.

"Want of provisions would soon have caused surrender, but with plenty of cartridges, the men would cheerfully have fought on for five or six days, or longer, if necessary on pork alone. Of this we had a sufficient quantity.

"No breach could have been effected in gorge at distance of battery on Cumming's Point, within a week or ten days, and with a small garrison its assault would have been doubtful."

GUNNERY DATA

Shots fired.—

Sullivan's Island,	
Mortar Battery No. 1	185, 10-inch.
Mortar Battery No. 2	88, 10-inch.
Mount Pleasant Battery	81, 10-inch.
Point Battery	61, 9-inch.
Fort Moultrie,	
64-pounders	248
32- "	305
24- "	105
Enfilade Battery,	
32-pounders	300
24- "	300
(125 shots per gun).	

Floating Battery,	
42-pounders	247
32-pounders	223
Hot shot (Fort Moultrie)	41
Cummings Point,	
Iron-clad Battery,	60
	183 solid shot
Other batteries on Cumming's Point,	
Mortars	197 shell
42-pounders	303 solid shot
	3 grape shot
Rifled Gun Battery	11 shot.
	19 shell
Trapier Battery	170 shell

The expenditure from Fort Sumter is not tabulated as its ammunition expenditure in general terms may be seen from account already given.

Rates of fire.—

Fort Moultrie,

42-pounders, 4 shot from each gun per hour.

Iron-clad Battery (Cumming's Point) 15-minute intervals between shots.

Mortars,

At first four-, then six-, and later eight-minute intervals between shot; night rate during bombardment, at times one shell in two to three hours.

Trapier Battery,

One shell from each mortar and three from the battery every 32 minutes, afterwards reduced to four-minute intervals and later a shell every twenty minutes.

Regular mortar intervals.—

Day time, two minutes between shots,

Night time, ten minutes between shots.

Casualties.—

Fort Moultrie, 4 men slightly wounded,

Fort Sumter, 5 men slightly wounded.

COMMENTS

The defense of Fort Sumter may be said to have failed, due to some of the following causes:—

1. Non-fire-proof buildings immediately in rear of the batteries, which caught fire and added to the difficulties of manning the works.

2. Lack of overhead cover for guns in barbette tier and for mortars on parade ground. This armament was useless due to high angle fire of opposing works.

3. Lack of subsistence supplies sufficient for the garrison to stand a siege of any duration and trying to relieve the fort when too late.

4. Lack of artillery supplies, such as cartridge-bags, primers, shell, etc.

5. Lack of means for cummunicating with relieving fleet.

6. No definite instructions for Major Anderson as to his own status, or as to his course if attacked.

7. Detachment of naval vessel by order of the President, without informing the Navy Department, so that another vessel might be sent in its place.

8. Waiting for actual outbreak of hostilities and then attempting to reinforce a work with men, supplies, etc.

9. Garrison absolutely inadequate for armament. Fort Sumter was said to require 650 men to man it.

10. Lack of mortars, making it impossible to combat hostile mortars.

Particular points to be noted:—

1. Novel defense measures taken by Captain Foster, Corps of Engineers, and energetically carried out, raising its defense power considerably, especially in case of an assault.

2. Fire direction extremely simple and apparently workable under battle conditions.

3. Novel use of Floating Battery on part of the Confederates against Fort Sumter.

4. Construction of Iron-clad battery.

5. Conversion of barbette guns on Fort Moultrie into casemate guns by use of merlons, splinter proofs, etc.

6. Great expenditure of ammunition on both sides, showing what may be termed "the usual results of bombardments."

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PROFESSIONAL NOTES

THE PROPER CALIBER FOR THE HIGH POWER GUNS OF SEA-COAST BATTERIES

By Captain Edoardo de Vonderweid, Italian Artillery

Translated from the Italian by Captain G. A. Taylor, C. A. C., U. S. A.

In the November, 1910, number of the *Rivista*, Captain Pappalardo treated the readers of the magazine to a noteworthy article upon the subject of the proper types of armament and ammunition for coast batteries. He concluded with a reiteration of the opinion, which he himself had first expressed the preceding year, that the proper calibers for seacoast guns lay between 152 and 240 mm. (5.98 to 9.45 inches), and that only for the purpose of meeting exceptional conditions should this latter limit ever be exceeded.

The question of the proper caliber for seacoast guns is most assuredly not a new one. Many and varied are the arguments, which have been advanced in favor of one or other caliber of gun, which was considered most suitable for installation in the defenses of a maritime country. However, should the fact that it is the present tendency to arm warships with guns of not excessively large caliber, be regarded as an irrefutable argument in favor of the foregoing contention. Should we not, perhaps, be inclined to admit that the proper caliber for seacoast guns may possibly be 240 mm. (9.45 inches) but no less?

While not regarding his arguments as absolutely worthless, the readers of the *Rivista* seem to be of an almost unanimous opinion adverse to that advanced by Captain Pappalardo. The idea most generally held is that possibly the limiting caliber, which has been 305 mm. (12 in.) up to the present time, will have to be increased as the naval standards increase, in order to keep abreast of the times.

The advocates of the "reduced caliber theory" advance the following arguments in support of their contention:—

1. That it is folly to overestimate the value of long range guns, and construct weapons having maximum ranges of 12 to 14 kilometers (13,123 to 15,310 yds.);
2. That the zone lying between 8 and 14 kilometers (8749 and 15,310 yds.) may be effectively covered by the fire of large caliber howitzers (mortars and hence fewer guns will be required;
3. That at the shorter ranges 240 mm. (9.45 in.) guns are capable of inflicting considerable damage upon any ship, and, in a short time, force them to withdraw from action.
4. That the greater rate of fire attainable renders it possible to accomplish the desired results quickly and effectively.

5. That finally, the life of a gun grows much shorter as the caliber increases, and, possibly even when needed most a large caliber gun might not be in proper service condition.

Translator's Note.—The efforts that are being made to counteract the effects of erosion may render this argument devoid of weight.

He who does not see the fallacies in the arguments advanced above must be so firmly wedded to the theories of the old school as to be incapable of forming an unbiased opinion. The pet theory of the old school was that any coast could be effectively defended with howitzers, and that if it was desirable to have any guns at all they should be of small caliber only, and for exclusive use against submarines, torpedo-boats, and such.

The difference of opinion between the old and the new schools is as to the efficacy of employing large caliber guns at short range. Assuming the possible superiority of howitzer fire, the old school authorities jumped at the conclusion that there was no particular virtue in the employment of heavy guns. The new school, however, appreciates the limitations of howitzers for use at the shorter ranges, and inclines toward the employment of gun of large caliber. We must acknowledge that the old school has solved the proposition in a very happy manner, that is from their own point of view. Indeed the old school advocates, although they consider water-batteries for short range fire, do not favor the location of howitzer batteries at some distance back from the water front; they base their main arguments on the greater efficiency of howitzers under the proper conditions, and that they may be afforded greatly superior protection. Some advance the rather strange argument that, when the enemy's fleet approaches within short range, and the action becomes general, and the rate of fire is much more rapid than is possible at long range, even then the superiority of howitzer (mortar) batteries is manifested and maintained, for the reason that, in spite of the volume of fire from the ships, the howitzer batteries, owing to their superior protection, can be injured but little.

However, in the cases where the fire of the enemy is not directed against the howitzer batteries, their fire possesses notable advantage over the fire of a hostile fleet, for then the rate of fire does not have to be excessively rapid.

One argument in support of this statement is that, when the harbor to be defended is not wanting in obstructions, such as submarine mines and other analogous means of defense, the fleet may be kept at a respectful distance.

Another is that, when the attack is not being directed against them, howitzer batteries can be served as if at target practice, and, under such ideal conditions, their fire would have a moral effect hardly inferior to the actual material damage inflicted.

Be it as it may, the foregoing arguments serve to demonstrate nothing conclusively, except that, as compared with guns of modest caliber, the confidence to be placed in howitzers is of a merely relative value.

The author prefers direct reasoning to the indirect methods of the foregoing; hence he proposes to abandon this line of reasoning, and allow the reader to draw his own conclusions therefrom.

Translator's Note.—Although the terms mortar and howitzer are by no means synonyms, we may glean from certain portions of the foregoing treatment of the subject of howitzers, certain facts which well apply to our own mortar situation in this country. Last summer the translator was

discussing with a certain District Commander, who commands an important New England district, the subject of the tactical employment of mortars. The point was brought out that, if mortars were constructed more on the principle of howitzers, and that, if curved fire were possible with them, their efficiency in that particular district would be about doubled. As it is, in the case of a run-by, the enemy's fleet might, particularly in foggy weather, attain with ease such a position that an expensive, poorly located, and over-protected mortar battery would be practically useless.

I.

In cases where gun-fire is employed at very long ranges, the following may be stated:—

a. When the angle of fall is with incertain moderate limits, the kind of fire is known as curved fire, and when the angle is over this limit it is known as high-angle fire.

Translator's Note.—Bruff defines direct fire as "from guns with service charges, at all angles of elevation not exceeding 20°. Curved fire from guns, with less than service charges, and from howitzers and mortars, at all angles of elevation not exceeding 20°. High angle fire from howitzers and mortars at all angles of elevation exceeding 20°."

With curved and high-angle fire it cannot be expected that any tangible effect can be produced upon the freeboard, but this type of fire is particularly adapted for use against the deck, which is, per force, less protected.

b. The small probability of hitting the target, does not justify the attendant waste of ammunition.

c. The difficulty of spotting the shots precludes the possibility of a proper observation of fire.

It may be added that it never was an easy matter to observe the long range fire of guns, which are now obsolete, but how much greater are the difficulties attending the observation of fire at such enormous ranges as for instance from 15 to 16 kilometers, (15,502 to 16,596 yards)?

Unfortunately we have not available the firing data for the latest 305-mm. (12-inch) gun, however, it will suffice to compare the 305-mm. (12-inch) L/40, Austrian gun, which employs a velocity of 700 meters per second, (2297 f.s.), and our own 321-mm. (12.6-inch) gun. (L/40 means 40 calibers in length.)

We have the following table of data for the 50% zone:—

Width of the 50% zone		Corresponding Range	
		12.6-inch gun	12-inch gun
meters	yards	yards	yards
80	87	7327	15,638
90	98	7874	17,169
100	109	8311	18,325
110	120	8749	19,466
120	131	9186	—
140	153	9733	—

For the angle of fall we have the following table:—

Angle of fall	Corresponding Range	
degrees	12.6-inch gun	12-inch gun
15	5796	15,529
17.5	6343	16,951
20	6890	18,263
22.5	7327	19,247

What a difference there will be in the figures for the 321-mm. (12.6-inch) gun and the 305-mm. (12-inch) L/50 Krupp gun, which is to have an initial velocity of 939 meters per second (3060 f.s.), and with an elevation of 10 degrees will attain a range of 16,500 meters, (18,012 yards)?

[*Author's Note.*—The United States Navy has recently been conducting experiments with a 305-mm. (12-inch) gun, which employs a velocity of 700 meters per second (2297 f.s.). At 8200 meters, (8968 yards), and using for a target an armor plate 4 meters, (1.37 yards), high, they demonstrated that they could readily correct their fire so as to hit the target at the second shot. At another similar target they proved that they could raise the range 25 meters (27 yards), and the two projectiles would hit in almost the same identical spot.]

At this writing it is not practicable for us to go very deeply into the question of what the probability of fire of this gun will be, but it is possible to make with considerable certainty the general statement that the new 305-mm. (12-inch) gun will possess a degree of accuracy of fire at ranges between 16 and 18 kilometers, (17,498 to 19,684 yards), which will be in no way inferior to that of the present 321-mm. (12.6-inch) gun at ranges from 4 to 5 kilometers, (4371 to 5468 yards), an accuracy of fire which will be quite sufficient. The only cause for worry is that the position-finding instruments may not be able to furnish data sufficiently accurate for such guns. In considering the subject of position-finding instruments for use at such long ranges, it is axiomatic that, if possible, the system should be so accurate that the unavoidable inaccuracies of range will lie within the limits of the probability of fire of the gun. For this purpose there are two systems:—

a. The vertical base system, which is very convenient, and which is employed, when sufficient height of site may be obtained.

b. The horizontal base system, which is employed otherwise.

There is a strong possibility that range-measuring instruments may be so improved as to increase the accuracy of the long-range results obtained.

Let us consider what perforating power the projectile of this gun will have. Suppose that it may be possible to secure data corresponding to the available data upon the subject of the influence of the angle of fall upon the amount of perforation to be expected. We may assume that to all intents and purposes the influence of the angle of fall upon the perforating power of the new 305-mm. (12-inch) gun will be practically negligible.

[*Author's Note.*—Employing the perforation formula, which has been devised by the Krupps, and which is

$$S = \sqrt[0.7]{\frac{V_r\ p^{0.5}\ \sin A}{C\ d^{0.75}}}$$

and assuming the angle of fall to be 13 degrees, the amount of perforation is calculated to be about 96% of that which would be obtained at normal impact.]

Of course the perforating power of the projectile will fall off with the increase in range and the consequent diminution of velocity, but the loss of striking power cannot be blamed upon the angle of fall. With the 305-mm. (12-inch) L/50 Krupp gun, cited above, which employs a projectile weighing 390 kilograms, (860 lbs.) we may calculate the remaining velocity at 16,500 meters (18,042 yards), as being about 415 meters per second, (1362 f.s.), which will give about 240-mm. (9.45-inches) perforation in Krupp cemented armor (K.C.), which exceeds the thickness of the greater portion of the belt of a battleship. Consequently we may be assured of adequate perforating power, unless we reduce the caliber below 305-mm. (12-inches).

The difficulties which attend the observation of long-range fire, with the means which are at present at our disposal, are certainly worthy of note. However, can we assume that these difficulties are insurmountable? It suffices to say that the modern tendency is towards the adoption of a method of conducting fire, in which the deviation corrections are accurately computed before the shots are fired.

In line with what has been previously stated, we may say that cannon cannot now be conveniently employed at excessively great ranges, that is to say at least, not above 14 kilometers, (15,310 yards).

Captain Pappalardo strengthens his position and comforts himself with the citation of certain data; but the cannon which were used at Port Arthur came a long way from possessing the characteristics of modern guns, and cannot serve as a criterion for the conditions to be expected in the next war.

In view of the foregoing, we cannot conclusively state that it will never be possible to employ guns at the longer ranges, but we must keep abreast of, and ahead of, if possible, the development of naval guns, perfect our fire-control materiel, and improve our position-finding instruments, which are too antiquated by far.

If we can increase the effective ranges of our guns to such a limit, we may rest assured that the coast will be well protected, in case of an attack by a hostile fleet. It is at best a difficult matter for warships to approach close enough to the batteries to bring all of their numerous guns into action in a general bombardment of the coast batteries, which can employ their fire without difficulty at ranges as great as 14 kilometers (15,310 yards), which range Captain Pappalardo assigns for the maximum effective range of his modern medium caliber guns.

However, it will not be out of place to add that, even if we exclude from the consideration extreme range action with coast batteries, we must, nevertheless, come back to the proposition that it is absolutely indispensable we should have plenty of rapid-fire guns for quick action against torpedo-boats and submarines.

II.

Captain Pappalardo is convinced that we should assign only howitzer batteries for ranges over 8 kilometers (8749 yards), for the following reasons:—

First, since the inferior accuracy of fire of howitzer batteries, as compared with that of guns, may be made up for by increasing the number of batteries and pieces.

Second, since the hitting effect of howitzers at this range, upon the exposed portions of the ships, is admitted to be more effective than that of guns.

In the abstract, the first argument has weight, provided that no difficulty is encountered in increasing the number of howitzer batteries, and the number of pieces, and provided that a sufficient volume of effective fire may be directed upon the vessels of the attacking fleet, and also provided that the attacking fleet cannot be maneuvered so as to escape the full effect, or render ineffective the howitzer fire directed upon it.

However, if we consider the expense attendant upon increasing the number of batteries and pieces, from a purely financial point of view, (and the writer is inclined to believe that there would be a lack of funds), the aspect of the situation is changed.

Translator's Note.—The fallacy in the premise of Captain Pappalardo's argument, which provides for increasing the number of howitzers to make up for their alleged inefficiency, is quite evident. The translator is a believer in the efficacy of mortar fire. The consummate logic with which Captain de Vonderweid tears to pieces Captain Pappalardo's arguments cannot but remind one of the old quotation "Oh, that mine enemy would write a book".

Captain Pappalardo in one of his articles states that a 305-mm. (12-inch) gun has a life of 100 rounds, costing 1,200,000 lire, ($230,400), as compared with a howitzer of the same caliber, to which he assigns a life of 250 rounds, costing 450,000 lire, ($86,400). The difference in favor of the howitzer is evident, but it depends wholly upon the assumption that the cost of a shot from a cannon is 3000 lire, ($576), and that the cost of one from a howitzer is 1000 lire ($192).

Considering that the projectiles for the two types of arms possess very different characteristics, they are nevertheless of about the same weight, and, considering that howitzer projectiles contain a much greater quantity of explosive, they may be considered equally expensive, or even more expensive than gun projectiles of like caliber. However, the difference in the comparative cost of a round is in the propelling charge, which, in the case of howitzers, seldom exceeds 80-100 kilograms (176-221 lbs.), but even this only reduces the cost of a round by about 500 lire, ($96).

With these few corrections we will find that the 250 rounds, assigned as the life of a howitzer, will cost in the aggregate 25,000 lire, ($158,400).

Again, supposing that the construction of the emplacements for a battery of four guns, or a battery of six howitzers costs the same amount or 800,000 lire, ($153,600), if we assume that four batteries of six 305-mm. (12-inch) howitzers will cost 23,000,000 lire ($1,116,000), then three batteries of four 305-mm. (12-inch) guns will cost only 16,800,000 lire, ($3,225,600).

If we add to this amount the pay and cost of maintenance of the extra personnel, which would be required in excess of that requisite for gun batteries, the comparison of figures will not be very favorable to the theory that howitzer batteries are more economical than gun batteries. As a matter of fact, for the service of a four-gun battery 150 men are quite sufficient, but for a battery of six howitzers, 250 men are barely sufficient, which means a war strength of 550 men, as compared with the usual two-company peace

assignment. This means an additional expense of about 100,000 lire, ($192, 000), and that the total cost of maintaining the coast artillery would be increased by about nine million lire, ($1,728,000), a sum which is most assuredly not negligible.

However, aside from the purely financial status of the question, what sum of money could recompense the service for the number of men seemingly needlessly employed at howitzer batteries?

It is needless to explain that an increase in the number of howitzers is a poor way of increasing their efficiency of fire.

As a matter of fact, 24 howitzers will hardly produce as great results as 12 guns, since the width of the 50% zone of the former does not compare at all favorably with that of the latter.

In fire over water areas, as we have noted, the extent of the 50% zone is much more important than are the usual accuracies of the results obtained with the position-finding instruments. The principal factor for consideration is, therefore, the mean probable error, for the computation of which Siacci gives the formula:

$$p + \frac{A - p \tan \varepsilon}{\tan \omega}$$

Taking p tan ε at its smallest value for long range, and assuming p = 25 meters, (27.3 yards), and assuming A = 5, we obtain for guns an error of 72 meters (78.7 yards), for an angle of fall of 6 degrees, while for howitzers with an angle of fall of 40 degrees, the error will be about 31 meters, (43.8 yards).

However, this is far from conclusive evidence in favor of howitzers, for we must take into consideration the following facts in regard to howitzer fire:—

a. The variations in the atmospheric conditions at high altitudes are unquestionably sources of error.

b. The determination of the position of the target at a given time is only an approximation, owing to the length of the time of flight.

c. The proper corrections for velocity cannot be made with any degree of accuracy, except during a prolonged action.

There are other considerations, of which it is needless to speak, which substantiate the assumption that the probability of fire with howitzers is much inferior to that possible with guns. Indeed the fire of 24 howitzers probably would not equal that of 12 guns, that is, as far as real results are concerned.

In regard to the second assertion that at from 8 to 12 kilometers (8749-13,123 yards) howitzers are able to maintain a fire effect superior to that of guns, we may say that this point has not been, and could not have been, satisfactorily settled in the past. There are those who still affirm that howitzer batteries are the proper type of defense for our coasts, when only with heavy modern guns is it possible to hope to penetrate at long ranges the heavy armor of the belts of the battleships of today. The Russo-Japanese War demonstrated the fact that, even at relatively short ranges, there was not one single case on either side, in which the armor belt was perforated with a 305-mm. (12-inch) projectile. However, the experiments on the French cruiser *Jena* will have a broad effect, as it becomes generally known that a plate 320 mm. (12.59 inches) in thickness was perforated at a range of 12,000 meters (13,124 yards).

However, it must be acknowledged that in the Russo-Japanese War the striking powers of the projectiles employed left much to be desired, and we must likewise admit that, if not at the present writing, certainly in the future the question of the amount of perforation possible at long ranges will be solved by certain fixed laws, which may be known for the actual service conditions existent, having been previously determined by the law of the resolution of forces, the computations being dependent upon the results of actual firing.

In the consideration of this proposition we may note that the amount of perforation at long ranges depends to a large extent upon the relative position or direction assumed by the point of the projectile. The longer the projectile is, the nearer is the axis of the projectile, during flight, to being tangent to the trajectory, the ideal condition to be sought.

It happens that the insertion of the point of the projectile within the plate exerts upon that portion of the projectile a bending and shearing stress, on account of the residual momentum of remaining portion of the projectile, and it results that the anterior portion of the projectile diverges from the direction of the trajectory, that is to say, when the trajectory is not, as it were, rectilinear, or rather practically so. In the solution of the problem of the influence which this force exerts upon the projectile, it may be determined what the limits of perforation are, the point at which the resistance of the projectile to rupture gives way, and likewise at what angle the projectile entirely ceases to "bite."

We cannot say that the problem may be solved without encountering some difficulties, for the torsion produced by the rotation of the projectile is manifested rather differently in the case of the portion of the projectile actually within the plate, than it is in the case of the portion of the projectile which is necessarily not so encased.

The addition of a cap to a projectile not only allows the projectile to continue its rotation as it passes into the plate, but also permits the center of gravity of the projectile to continue freely that movement, which tends to turn the point of the projectile directly into the plate.

It would seem that the time is now ripe for the elimination of the obstacles which have hitherto withstood the efforts made toward the proper solution of the problem of armor perforation, and that we may look forward to having at last an irresistible projectile.

However, whether or not this ideal is to be attained, can we not assert that, beyond any question of doubt, the projectiles of modern direct-fire guns are capable of greater possibilities than are those of howitzers, and are thus more efficient?

The vitals of a ship are, as a rule, located under the protective deck, hence a howitzer projectile cannot carry such death and destruction into the vitals, as is generally supposed, for the reason that the projectile is deviated from its course by contact with portions of the superstructure *et cetera*, and does not get a fair chance at the protective deck. I doubt very much as to whether the confusion produced by the damage to the superstructure *et cetera* will really result in the destruction of the vessel. However, gun-fire, even if it does not perforate, has without doubt a very sensible effect, which opinion is borne out by the experiences of the Russian fleet in the Battle of Tsushima, August 27, 1904, in regard to which Admiral Rojestvensky stated, "No armor belt was perforated by the enemy's projectiles; however, by their

repeated blows and explosions against the sides of the vessels, the enemy's projectiles loosened the plates, broke their fastenings and created such damage that the ships sprung leaks, listed to one side or the other, and turned turtle." What more do you wish?

In the bombardment of Port Arthur by the 280-mm. (11-inch) howitzers, the advocates of howitzer-fire may find food for thought in the fact that no Russian ship was seriously injured by curved fire.

If they still persist in the assertion that howitzers excel at long ranges, I can prove that at long ranges guns are certainly not inferior to howitzers.

Would it be possible to exclude gun batteries from taking part in an action at all ranges, as I advocate they should? At least this is not absolutely possible, for the presence of guns in the defense necessarily has a certain effect upon the mode of attack to be employed by the enemy, in fact they preclude the possibility of the enemy's being able to maneuver his fleet, so as to avoid the fire of the batteries. If a harbor possessed only one battery of guns, and the remaining batteries were all howitzers, I still believe that the defense could be successfully conducted, for the one gun battery would be able to direct its fire upon the whole fleet or any part of it, firing at short intervals, and with such effect as to be able to paralyze its action.

Likewise, the howitzers, acting within their true limitations, the difficulties presented by too rapidly moving targets having been overcome, could maintain a strong fire, but which would nevertheless be somewhat undependable and uncertain in its effect.

In the last analysis, the employment of guns at all ranges, in proper cooperation with howitzer batteries, is conducive to economy in expenditure as well as personnel, for in this way the number of howitzer batteries may be reduced to a minimum.

(To be concluded.)

✤ ✤ ✤

SUBMARINE MINE DEFENSE OF COAST FORTRESSES

(An Essay of Investigation)

INTRODUCTION

In examining a fortification on dry land (a battery, fort, trench, etc.) we are accustomed to see some sort of abstacle or barrier before it; we have grown so completely accustomed to this idea, that we cannot imagine a defensive fortification without some obstacle to bar the approach to it and if nature has not supplied one we erect it ourselves as soon as possible. In a word, the necessity of having some kind of obstacle before a fortress has become a custom with us.

There are no reasons for applying any other standard to a coast fortress; there also, we want to see obstacles before any fortifications and if nature has not created any, we must take this task upon ourselves. The only difference between land and sea conditions lies in the scale, on which we have to act. If on land we have to deal with men, to drive back or destroy men, at sea we have to do the same with battleships. If on land the obstacle is placed forward at a distance measured by hundreds of yards, on sea this distance is increased to thousands of sajens (1 sajen = 7 feet). If in war

operations on land we have both passive (nets, pits, etc.) and active (fougasses, stone-throwers, mines) obstacles, we must have the same before the front of a coast fortress, the passive obstacle in this case being embankments, moles, nets, booms, etc., and the active ones—mine barriers. If the erection of passive obstacles on land requires days, on sea it takes months and even years. Only in regard to the time required for the installation of active obstacles, land and sea may be put on practically the same scale—one or several days.

Taking into consideration all that has been said above and the fact that for laying active obstacles on land we shall be able to dispose of much more time than on sea*, it will be obvious that every inland fortress is in far more favorable conditions, than a coast fortress.

Passing over now to the submarine mine barriers, we will consider both sides of the question: the technical and the tactical part.

In the present essay the technics are considered as far as it is necessary for the elucidation of the subject. We endeavored not to pass the limits in which this question was treated in some studies which were published after the war in the Engineering Review (Russian Engineering Journal) and the Military Magazine (Russian Voenny Sbornik). The tactical part of the essay, as far as we know, is published for the first time, until now we could not find any mention of the matter, even in manuals.

We shall thus divide our work into two parts; the technical and the tactical part. In the first we propose to give as full an account as possible of the present condition of the technics of submarine mine work and in the second we will deal with the tactical side of the system of obstruction by mines, *i. e.*, answer the question in what way the laying of mines may be of assistance in the defense of a coast fortress.

However, we are obliged to mention that the technical and tactical sides of submarine mining are so closely connected, that in the first part we shall deal also with questions belonging to tactics, and in the second—with questions belonging to technics.

Part I.

TECHNICAL PART

Chapter I.

Classifications of Systems of Barriers

The barriers placed in water areas of coast fortresses and destined to prevent the enemy's fleet from fulfilling its part in the attack must be divided into two quite different kinds. The first kind consist of such barriers, that not only stop the advance of the enemy's ships, but also damage or destroy the same; these may be called active† ones. Barriers of the second kind only serve to stop the enemy's ships, being passive obstructions in the real sense of the word, as for instance, moles, ballasted sunk chests, heaps of stones nets, booms, estocades, etc.

* The enemy may appear before an inland fortress not earlier than several days after the declaration of war, and before a coast fortress only some hours after, or even before the declaration of war. (Port Arthur, 1904.)

† Certainly, all barriers before any fortress must be called passive ones, but in consideration of the part that some of them have to play (fougasses in a war by land, and mines in coast fortresses) they are called active barriers. Properly speaking, the active barriers, represent the ideal of a defense, because it is said: "an active defense is the best system of defense."

Chapter II.

Active Barriers

Active barriers will be consequently such barriers, which not only bar the enemy's ships progress, but also cause them damage by destroying their hulls. Mines are efficient against all kinds of ships, but it is to be noted that the types of mines to be used against small boats (torpedo boats of the coast defense, torpedo cutters, etc.,) are unknown to us. Besides the technical difficulties attendant on the laying of such mines, it seems hardly worth while to resort to such strong measures for such small objects, therefore we think that the only reliable and efficient measures against small boats are nets, booms, of which we will speak later (in Chapter 3).

A mine barrier is an artificial barrier composed of a series of submerged hermetically closed cases containing a sufficient quantity of explosives to destroy hulls of a modern warship; such cases are called submarine mines.

The quantity of the explosive with which the mine is charged must be calculated so as to enable the mine in exploding to cause a leak in the ship that would render it unfit for further action.*.

Chapter III.

Classification of Mines

All types of mines known are divided according to their destination into:

1. Mines of attack, or active mines, and
2. Defensive or passive mines.

We shall speak of the former, because their object is not at all the defense of the coast; they are destined for action against the enemy's ships in a battle (self-propelling mines), and for action near the enemy's coast (obstruction mines), for blocking up the enemy's fleet in its own harbor. These are the necessary attributes of a fleet; all ships are supplied with self-propelling mines (Whitehead, Bliss-Levitt) and torpedo boats, mine laying boats, and lately, submarines are supplied with obstruction mines.

Passive or defensive mines are used for the defense of the coasts and placed at a certain distance from the defended point either at the bottom of the sea or at a certain depth† (by means of an anchor).

Passive mines are divided:

a. According to the manner of laying them, into:

1. *Ground mines,* which are kept at the bottom of the sea by their own weight; such mines are heavier than the volume of water displaced by them or, as it is called, they have a negative buoyancy. As they are not destined to explode in the immediate vicinity of the ships, they must have a heavy charge of explosives and this is their drawback. But one of their advantages is the great difficulty of destroying a barrier built of such mines (countermining, trawling, etc.)

2. *Floating mines,* which are kept at a certain depth by means of anchors or ballasts; these have a positive buoyancy, as they are destined to explode immediately near the ship's side, they have a comparatively small

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* It is erroneous to think that a mine must sink a ship. The cases that occurred in the last campaign were not occasioned by reason of the enormous charges laid in the mines, but by defects in the construction of the ships. The explosion of the mine under the ships caused explosions of the gunpowders, stores, boilers, etc., and this caused the immediate sinking of the ships (*Petropavlovsk, Hatsuse*).

† The distance from the surface of the water to the mine is called the depth of the mine.

charge of explosives, but they "encumber" the space; when passing them the home ships frequently damage their cases; and

3. *Drifting mines*, which float on the surface of the water, or at a certain depth* and are driven towards the enemy by the current or the wind. To this class may be added such mines, which serve as drifting mines, during a given period of time (by means of clockwork) afterwards becoming floating mines, *i.e.*, stopping automatically on their anchors at the point to which they have been driven by the wind or the current after the given period of time has elapsed. Drifting mines are seldom used and should rather be considered as active mines.

b. According to the explosive appliances, passive mines may be divided into:

1. *Percussion mines*, which are again divided into two categories, acting either by mechanical or by pyrotechnical percussion.

To the first category belong the mines in which the explosion is caused by the letting down of a cock onto a percussion cap. The second category contains mines which explode in consequence of a chemical reaction between certain substances, which produces a considerable amount of heat, for instance, potassium and water, sulphuric acid and a mixture of chlorate of potassium and sugar, etc.

The mines of the first category were not used for a time, but there is evidently again a change in their favor (for active mines). The second category presents now only a historical interest.

2. *Electric mines*, which are exploded by means of an electric current. As will be seen these are the mines that serve especially as passive mines.

c. According to position of the source of electricity, the electric mines may be divided into stationary and electro-percussion mines.

1. *Stationary mines* are connected by a conduit (wire cable) with the coast, where a station with an electric battery, supplying the necessary current, is placed. This method enables one at any given moment: (a) to bring the mines from a safe condition (during the movement of our own ships, into a dangerous one (during the advancement of the enemy) and vice versa, and (b) to control the mines, namely, to ascertain the degree of efficiency of the mines.

2. *Electro-percussion mines* have a battery necessary for the explosion of the exploder placed either in the mine itself, or near it, (for instance, under the mine, in the anchor, etc.). Such mines cannot be controlled, nor rendered innocuous; therefore they can be used only in such places where our own ships will assuredly not pass.

It is obvious that notwithstanding many drawbacks -of which the principal ones are: (a) the necessity of having a great quantity of expensive and easily damageable conduits, and (b) the necessity of maintaining stations with a corresponding staff--stationary mines have one very valuable quality: *they are quite safe for their own ships, and dangerous for the enemy's fleet.* This quality which makes the stationary mines seem like sentient reasonable beings, is invaluable for the defense of our coasts.

It does not follow, however, that our own ships may pass the barriers with impunity to the latter; by knocking against the mines and especially by striking them with the blades of the screws, the ships may damage the cases of the mines and even sink them. This concerns floating mines.

* Mines of this type have either a positive or a negative buoyancy; in the first case they are kept at a certain depth by means of round and comparatively light anchors; in the second case buoys (floats) are necessary.

d. According to the manner of ignition the stationary mines are divided into contact and observation mines.

1. *Electro-contact mines*—called also automatic mines—have a special apparatus the object of which is to close the current (electric circuit) when the mine is pushed, or when it is in an inclined position. The current will then pass through the vent of the mine and cause the explosion. When the mine is in a vertical position the circuit is open in the switch and the current can not pass through. The advantage of this method is that there is no need to determine the moment when the current must be sent through the circuit of the mine; the mine itself or rather its commutator will telegraph to the station on the shore that it is closed and at the station a strong battery will be automatically introduced, provided, certainly, that the mines are ready for action.

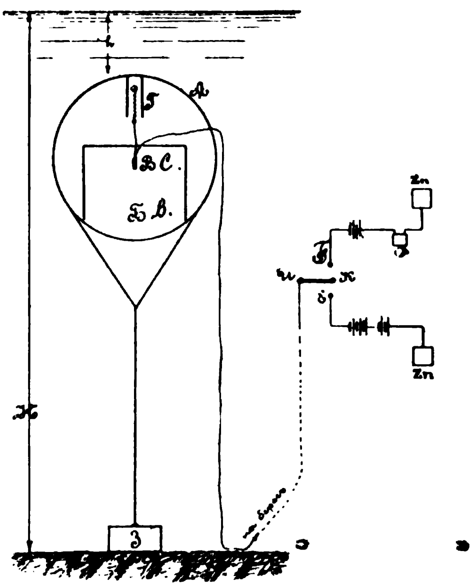

Fig. 1.

The contact method of ignition may be equally applied in all weathers and at any hour, etc., owing to the action of the commutator; yet, if the mines have to be laid in places where the sea is rough, or where there is a strong current, special attention must be paid to the sort of commutator used, because in case of an unsuccessful choice of commutator the same will close the current not only when the mine will be pushed by a ship (which is the object to be attained), but also by the action of the waves (which must be avoided).

2. *Observation mines*, the so-called "mines exploding on observation," require on the contrary certain appliances for determining the exact position of the ship over the mine, *i. e.*, the moment of the explosion must be fixed precisely. The preciseness of such a determination depends upon: (a) the distance, (b) the visual angle, which is usually taken from two points; the

most advantageous angles being those nearest to the right one, (c) the geographical position of the place—the condition of the weather, fog, cloudy or dark days, etc., (d) the precision of the instruments used for carrying out the observation, (e) the quality of the searchlights (at time). To rectify any errors by increasing the charges in the mines is impossible, as it would lead to enormous, even incredible, charges.

The annexed drawings will explain better all that has been said on the subject of stationary mines (contact and observation mines).*

Fig. 1 represents a floating contact mine. The commutator T is placed in the case of the mine itself A, which has a charge B with an exploder C. The mine having a positive buoyancy is held in its place by anchor S, a cable is conducted from the mine to the commutator G K on the shore. By moving it upwards to point F, we render the mine innocuous and if the

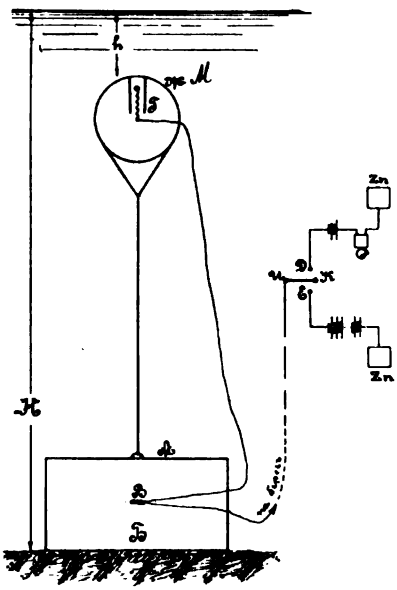

Fig. 2.

switch T closes the current, the bell will ring at the station; if the commutator be moved to point E, and the current be closed, a strong battery is inserted into the circuit and the current will pass through the exploder C, causing the whole charge B to explode.

Fig. 2 represents a ground contact-mine;as it has a negative buoyancy and lies at the bottom of the sea, it is necessary for transferring it into a contact mine, to annex to it a separate floating body M with a positive buoyancy and place the switch T in it. On the shore there is the requisite complement of appliances and batteries, which allow to set the mine in action, or to render the same innocuous.

I believe, that the described type of mine (the ground contact mine) will have an exceedingly limited appliance, if any at all; because (a) it re-

* In Figs. 1 to 4 *H* denotes the depth of the sea at that point, in Figs. 1 and 3 *h* denotes the depth of the mine, and in Figs. 2 and 4 *h* denotes the depth of the case with the commutator.

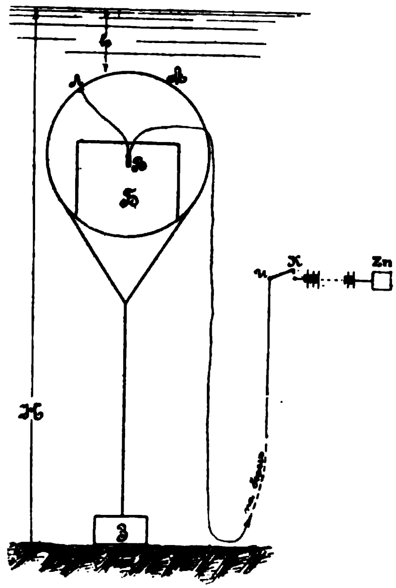

Fig. 3.

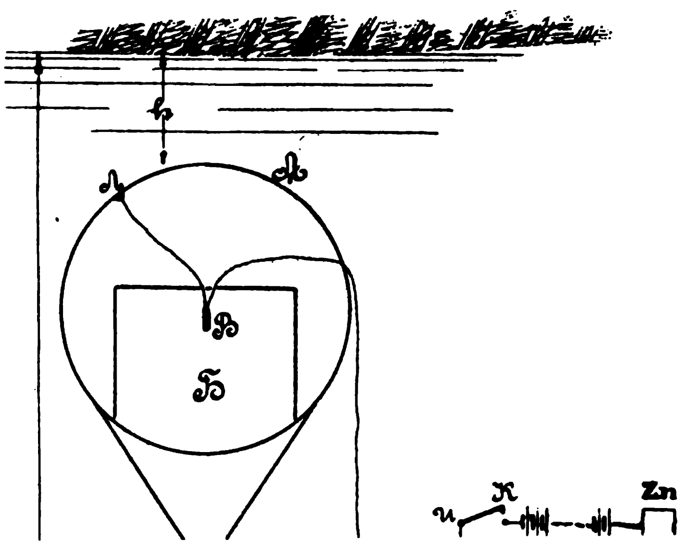

Fig. 4.

quires just as large a charge as any other ground mine, (b) separately floating switches obstruct the defended area, *i. e.*, they suffer from their own ships passing over them, and (c) separately floating switches can be destroyed by trawling, countermining; so that this type combines all the defects of ground and drifting mines, without possessing any advantages.

Fig. 3 represents a floating observation mine; no switch is necessary, the mine will explode at the moment when the key K, inserting a strong battery into the circuit with the switch, will be pressed at the station.

Fig. 4 representing an observation ground mine differs from Fig. 3 only in so far, that the mine is lying at the bottom, *i. e.*, its depth is equal to the depth of the sea at that spot.

Lastly, Fig. 5 gives a scheme of explosion "on ringing the bell," which represents a combination of both the above mentioned methods (the contact and observation ones); on a separate cable to which a bell is attached on the shore, a separately floating case L with a switch is placed; this switch is surrounded by four (or any other number) observation mines A, the cables

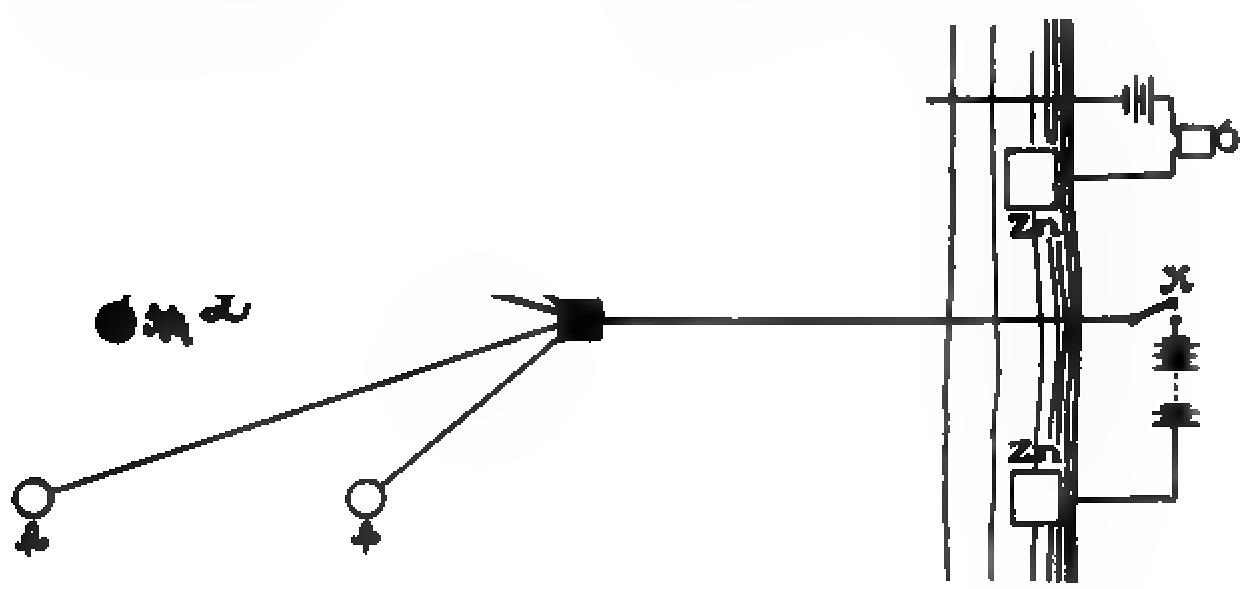

Fig. 5.

of which join together in knot M; from the latter a cable is conducted to the shore, where by means of key K it is connected with a strong battery. In executing an explosion on observation, after having ascertained precisely the position of the ship in the center of the four mines, the key K is pressed; should, however, any circumstances impede the observation (fog, darkness, smoke, etc.) the key is pressed only when the bell at the station rings in consequence of the action of the switch. This same method owing to the comparatively large distances between the mines and the simultaneous explosion of several mines at the same time, may allow one in doubtful cases* to consider whether the mines are to be exploded or not. Evidently, any error in determining the moment of explosion (by the observation, or the bell ringing method) may be redeemed in such case by the simultaneous explosion of several mines (two or more) any one of which may destroy a ship

Obviously, the bell-ringing method combines nearly all the advantages of floating and ground mines with, however, some of their defects.

* Certainly in times of war, there *should* be no "difficult cases," but that does not mean that there will *not* be any Hence, it is better to supply this method, as well as the method of explosion on obsertion only at short distances

The above classification of mines may be best expressed by the following formula:

a. *Destination:* passive (defensive) active (attack)

b. *Method of placing:* ground mines floating drifting

c. *Apparatus for exploding:* electric percussion electric

d. *Site of the elec. battery:* on the shore (stationary) in the mine (electro-percussion)

e. *Method of ignition:* (on observation) automatic (electro-contact mines)

In the description of the electro-contact mines (Fig.6), cable A, leading from the station to junction point B, after which it branches off, will be called the main conduit. Junction point B, to which cable A is conducted and from which the mine-ends a, branch off and the connecting cable C, leading to the next junction point S, and will be called the magazine junction point, or the magazine.

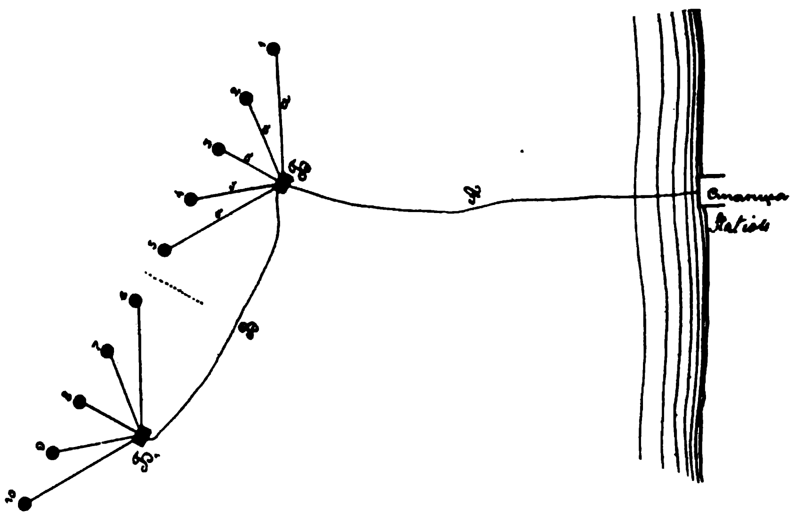

Fig. 6.

We will reckon 5 mines in one group and assume that on a main conduit of over 10 versts in length (about 7 miles) we can place one group with one magazine; on a conduit of 5 to 10 versts in length, we can place 2 groups, and lastly, on a conduit of not more than 5 versts we can place three magazines, that is to say, three groups. Naturally, these figures are only taken conditionally. If we place the group of mines in a row, as shown in Fig. 6, we will call such groups "line groups," if we have to form a shoal or bank

of mines, we will place the group in the form of a "star," as shown in Fig. 7. In using observation mines each mine must have a special cable leading from the station; if the explosion is effected on observation from two stations the latter must be connected by cables, the number of which must depend upon the positions of the stations in regard to the rows of mines.

Lastly, the methods of placing and the construction of the precussion and electro-percussion mines should provide for their being lifted out with perfect safety. Such mines should be placed only in "a line," otherwise they may be dangerous.

In concluding this chapter we think fit to say a few words on the subject of the dimensions of the charges in the mines.

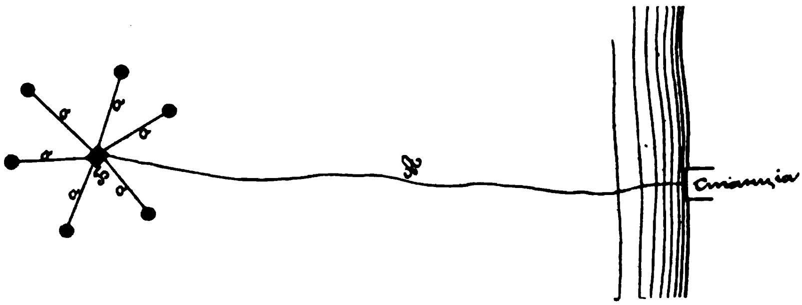

Fig. 7.

The dimensions of a charge for an observation ground mine are determined according to the following formula:

$$C = 0.25 \left(\frac{H^2 + D^2}{H}\right)^2$$

in which

C is the quantity of pyroxyline in lbs.

H = the depth of the mine (depth of the spot in feet).

D = ground-plane or horizontal projection of the distance from the mine to the object which is to be blown up (ship) in feet.

The dimensions of a charge for ground mines, exploding automatically, that is to say, at the moment when the ship is above the mine, may be obtained from the foregoing formula, assuming D to be equal to 0, then

$$C = 0.25\ H^2.$$

The charge for a floating observation mine may be determined according to the formula mentioned above for similar ground mines.

Lastly, the charge necessary for a floating mine has been established by practice as being *equal to about 5 poods* of pyroxyline. For Dreadnoughts such a charge would probably be 6 poods.

Chapter IV.

Nature of Mine Barriers

1. A mine barrier may be placed at any spot, beginning from the most shallow parts, where only small ships can pass and ending with depths of many scores of sajens (1 sajen is equal to 7 feet).

2. With the proper means at hand (staff of officers, ship and mining property) barriers may be erected promptly and with perfect safety.

The question of a "correspondence" between the means and the objects to be attained stands actually thus: (a) the personal staff of the mining companies is nearly exclusively composed of officers, who have studied the course of the Military Electrotechnical School, *i. e.*, who have received a sufficient theoretical and, what we consider as much more important in such a serious matter as submarine mines, practical training; (b) the mining supplies are in complete conformity with the objects against which they are destined to act. One should not forget, however, that considering the actual ever-increasing growth in the tonnage of warships, it may be that the supplies will soon prove to be insufficient, and it is quite probable that in 8 to 10 years' time the charges will have to be doubled.

In respect to the promptitude with which a mine barrier should be erected, we are assured that the sooner a barrier will be placed, the better it will be for the defense of a fortress. No one, however, is so dependent on the weather, as the submarine miner laying passive mines, considering, as will be mentioned further, the necessity of laying the same at a certain distance from the coast, at great depths, where the sea is rough, we may be allowed to affirm, that this work is very difficult and at times even impossible. We may express a wish that the methods of placing barriers be improved, or even modified, we are of the opinion, that this is an interesting theme and one which deserves to be worked out.

As regards the safety of the system, in the sense of the impossibility of a sudden explosion, we affirm most categorically that the laying and removing of stationary mines is an absolutely safe proceeding; in regard to electro-percussion mines, however, this security may be guaranteed only by a trained staff, the system itself for the laying and removing of mines rendering totally impossible the occurrence of such cases, as those which happened in Prussia during the years 70-71 of the last century, when in carrying out such manipulations about 170 men were killed.

3. The moral effect of submarine mines as of a hidden danger is tremendous. This may be best illustrated by examples:

a. A well armed frigate *Wabach*, with a hardy and energetic crew of 70 men, fled in April, 1864, before a small torpedo boat with 4 men.

b. In the same year on the river James, the gun-boat *Commodore Jones* moving at the head of a dead-water column, was blown up by a mine. "At the moment of the explosion not a sound was heard in the whole squadron, the silence was unbroken during a few seconds, and then suddenly, all the ships, as by command, turned and fled, pushing against one another in the narrow fair-way." (M. Boreskoff—Guide to the art of laying mines, as applied to submarine mine defense and hydro-technical works. St. P. 1876. Pages 17 and 18.)

c. Admiral Farragut testifies: "The idea alone of the vicinity of such a dangerous and invisible foe has an evil moral effect on the sailors and evokes fear."

d. During the war of 1866 the mines proved a good service to the Austrians, in as much as the enemy did not even come near to the places defended by them.

e. During the Franco-Prussian war in 1870-1871 the Germans reinforced the defenses of the mouths of rivers and all accessible points on the coasts of the Baltic and the North Seas, but their mines wrought no harm whatever to the French ships, for the reason that *not one of their ships* came

near the mined places, because the French could not find any pilot to conduct their ships. Evidently, the French did not even venture to force the barriers.

f. We all remember the panic that seized our squadron at the moment when the *Petropavlovsk* perished during the last war. The same occurred with the Japanese when the *Hatsuze* was destroyed.

It seems to us, that the facts related here confirm more eloquently than words all that has been said on the subject of the enormous moral effect produced by submarine mines. the moral effect, which according to Napoleon constitutes three quarters of success. If even in some cases the mines have not blown up any ships, they have nevertheless honorably fulfilled their object, namely, the protection of the points to be defended.

4. The mine barriers are powerful allies of the coast artillery. A mine barrier exceeds all other barriers in water areas by its activity; it will not only stop the advance of the enemy's ship, but will damage the same and render it useless. Naturally, the destruction of even one warship is of great advantage to the coast artillery, as after that it will have to deal with a smaller force. Besides this, the presence of a mine barrier in places which may present advantageous positions for the enemy's fleet, may oblige the same to give up these positions, consequently, by employing mines rationally, we abolish dead spaces. A good illustration of such a successful application of submarine mines was the erection of mine banks at Liaoteshan in Port Arthur (where the *Hatsuze* and *Ioshimo* were destroyed), which stopped the indirect fire of the Japanese on the inner basin.

5. *The trawling and destroying of mines is difficult and very dangerous, requiring much time and a well-trained staff of men.*

Two cases must be examined: (1) when the mines are laid so as to be under the fire of the coast artillery (a normal case) and (2) when they are laid beyond such fire (mostly an exceptional one). In both cases we must not forget that the exact spot where the mine barrier is placed, is unknown to the enemy; to ascertain the same he must either use spies or else—learn it by bitter experience—when one of his ships will be blown up. Generally, to find the mines it is necessary to have recourse to trawling, or to searching the bottom of the sea by means of "cats" (small four-armed anchors) which is very difficult work, owing to the necessity of trawling through a number of square versts, and sometimes even impossible, because it has to be carried out under the fire from the coast.

Consequently, in the first case (the mines laid under fire of the artillery) counter-mines will have to be used; this operation, demanding enormous quantities of explosives, will hardly answer its purpose notwithstanding all the methods recommended by tactics (the most efficacious being, as it seems, the "smoke veil" which apparently has never yet been tried by any one).

In the second class (mines laid beyond the range of fire) the requisite results would hardly be attained by means of the trawl or the "cat" for the reasons above mentioned. Should the enemy even be lucky enough to trawl a mine (having blown it up, as the stations will undoubtedly set the mines in action) this circumstance, in disclosing the spot where the mine barrier is laid, will oblige the enemy to pass to the rear of the barrier, to find the cable by the help of the cats, and only after succeeding in cutting it (in several places probably) make him feel himself secure from danger. It may be assumed that the enemy, after trawling and blowing up one mine, will want

to do the same to all the others. In such case, evidently, he will have to spend much time over this operation.

All that has been said proves that the mine barriers must be under constant supervision: (a) each barrier must have its observation posts, connected by telephone with the corresponding mine stations; (b) searchlights must be used over the whole water area; and (c) the sentinel service, this weak point of the defense of a coast fortress, must be thoroughly organized so as to be completely up to the mark.

If all these conditions are complied with it seems to us that the destruction of the mine barriers and the casting of the enemy's mines among them* will become impossible.

6. *A mine defense costs considerably less than any other measures for the defense of a coast fortress.*

At a rough calculation we might say that each mine laid will cost about Rs. 2500 ($1250), counting herein the cost of the mining and ship property and the mine stations. Estimating the cost of a coast fortress: a small one at Rs. 60,000,000 ($30,000,000) and a large one at Rs. 100,000,000 ($50,000,000) and assuming that for the defense of the former 500 mines will be needed, and for the latter, 1000 mines, we find that the cost of a mine defense will represent 2.5% of the total value of the fortress.

From the aforesaid it will be seen that the submarine mines are one of the most important defensive measures of a coast fortress, but it is quite impossible to overlook the fact that this measure may prove efficient only in connection with all the others, among which the artillery must certainly occupy the first place. A coast fortress may only be recognized as impregnable, when all the measures for its defense will be in complete harmony with each other; we think that this harmony with each other must be especially perfect between the artillery and the submarine mines. We are convinced that if until now the words "coast fortress" have evoked the idea of merely a portion of the coast studded with steel mouths, ready at any moment to deal out death to any foe approaching them, or to salute a freind—from this moment to this picture will be added the certainty that not far from these steel monsters, somewhere under the water, the invisible mines lie modestly hidden yet ready at any moment by perishing themselves to destroy any foe who will dare to touch them, and at the same time are prepared to let pass freely a home ship or a friendly one.

It is thus that we picture to ourselves the defense of a coast fortress, a place on the coast defended only by artillery does not deserve this name.

(To be continued.)

—*Engineering Review* (*Russia*).

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MUSKETRY FOR THE ROYAL GARRISON ARTILLERY

By Captain C. J. D. Freeth, R. G. A.

"Since the issue of the rifle, the musketry of the R. G. A. has improved considerably, but a good deal yet remains to be done."

So wrote the Inspector of Garrison Artillery, in his annual report for

* This would transform our barrier of stationary mines—which is perfectly safe for our own vessel—into a barrier of equal danger for the enemy and for ourselves. The opponents of stationary mines generally point out this possibility, but we are assured that if the sentinel service (observation posts, searchlights, sentries) is organized as it should be, one may feel perfectly secure not only in regard to the mine barriers, but also in regard to the defense of the entire fortress.

1910-11, and the remark was considered by the Army Council of sufficient importance to warrant the issue of a special circular* with the object of encouraging officers of the R. G. A. to become more efficient instructors of musketry.

The keen garrison gunner naturally holds a thorough mastery of the tactics and drill of coast defense artillery to be of such vital importance that he is apt to overlook the value of musketry, which does not at first sight appear to be directly connected with his branch of the Service. It may be useful, therefore, to point out some of the reasons why gunners should not only become expert rifle shots, but should even look upon their rifles as an absolute necessity to their very existence as soldiers, "remembering always that they are garrison artillerymen, but never forgetting that they are soldiers."†

A glance at the part played by the fortress gunner in past wars will help us to realize the importance of a thorough training in the use of the rifle.

First let us consider the period before either belligerent has established naval supremacy. During this phase of the war the fortress gunner must devote himself wholly to the efficient fighting of his battery, and should almost forget that he even possesses a rifle. Notwithstanding this we find the following passage in the amendments to the 1905 edition of "Garrison Artillery Training":—

"Gunners are in no way intended to perform the duties of protection, but if not occupied in fighting their guns, will be expected to assist the infantry in resisting an attack on the rear of the work, except with anti-torpedo boat guns which may have to be manned at a moment's notice."‡

Again, General J. B. Richardson, lecturing to the Senior Officers' Class in 1893, said:—"The defense against landing raids, whether intended to be pushed home to the guns or merely as a diversion, is by far the best when entrusted to infantry. But in most of our sea fortresses regular infantry will be conspicuous by their absence, and the gunners will have to depend for their existence largely on irregular levies. I hold personally that garrison gunners should be taught to shoot accurately with small arms up to, say, 200 yards. They could then have a chance of repelling a close assault on their batteries."§

Thus it will be seen that, even in this stage of a war, the rifle is a necessary addition to the gunner's equipment; but, as General Richardson points out, the duty of repelling landing raids primarily belongs to the infantry, and gunners should not be diverted from fighting their guns as long as there is a possibility of the enemy's fleet co-operating with the land attack.

The Russo-Japanese war has proved beyond doubt that it is possible for military expeditionary forces to be transported to the enemy's territory by sea before the question of naval supremacy is settled.‖ It is, however, unlikely that a fortress will be called upon to resist an attack of any magnitude from the land side before the enemy has obtained command of the sea.

Let us then pass on to the period when naval supremacy has been established by one side or the other, and review the conditions which would obtain if England (a) lost command of the sea, (b) established her supremacy.

* 104 Arty. 2177 M.T. (2).
† "Army Training for Officers of the Royal Garrison Artillery," by Col. Stone. Journal of the Royal Artillery, Vol. 32, p. 394.
‡ "Garrison Artillery Training." Vol. 1, chap. VII.
§ The Journal of the Royal Artillery, Vol. 30, p. 31.
‖ "Letters on Amphibious Wars," by General Aston, p. 10.

Sir George Clarke, in his well-known work on Fortification asserts that if the British Navy were destroyed "our coast defences would at once cease to possess real national importance."* This is undoubtedly so, but there usually is an intermediary period between the time when naval supremacy hangs in the balance and the time when the fleet of one of the combatants completely destroyed. This was the case in the Chino-Japanese War of 1894, the Spanish-American War of 1898, and the Russo-Japanese War of 1904-5. In all these wars the countries which had obtained naval supremacy considered it necessary to attack one or more of the enemy's fortified ports. These attacks took place after the question of naval supremacy had been settled. The attacks were made, not on account of the intrinsic value of the fort itself, but in order that the remnants of the enemy's fleet might be completely annihilated. The attack on Port Arthur in 1894 was made in order that the Chinese fleet might be deprived of its protection. At Wei-hei-wei in 1895, at Santiago in 1898, and at Port Arthur in 1904, the attack on the fortress was made because the fleet had taken shelter beneath its walls.

Whether the stubborn defence of a port in circumstances such as these has any real influence on the result of a war or not, in no way concerns the soldier. It does, however, sometimes happen that there is an obvious advantage in holding out as long as possible. For instance, "if Stossel had continued to hold out at Port Arthur until the spring, Kuropatkin would have been able to take the offensive with far better chances to success;"† the battle of Mukden would have been fought without the fifth Japanese army, and the war might have ended very differently. But even if there is no apparent object in holding out, it is as unnecessary to impress on the British soldier that he must never surrender, as it would be to tell a doctor that he must preserve life as long as possible.

Thus, admit as we may that the chances of the command of the sea being wrested from our navy are extremely remote; still it behoves us to remember that, as Lord Roberts tells us, "it is the improbable that constantly happens in war."‡ We must, therefore, make a study of the defence of a fortress under such conditions lest we be found wanting at the critical moment.

Sir George Clarke, arguing from a long series of attacks on fortified ports spread over 2,300 years, from Syracuse 414 B.C. to 1893, has deduced the fact that "Attacks on an enemy's fortified ports across the sea are generally undertaken for naval objects, are practicable only on conditions of full naval superiority, and to be effective must assume the form of military operations on shore, supported by a covering naval force able to maintain communications."

"These military operations on shore may, of course, and often have been successfully carried out by sailors when their scale was comparatively small; but they may nevertheless be distinguished from the direct naval attack which specialised coast defences are intended to oppose."§

He speaks of the land defences of a fortress as the "back door, which as history clearly shows, is the one usually selected; and in closing this back

* "Fortification," by Sir George Clarke, p. 181.
† "The Siege of Port Arthur," by Ashmead Bartlett, p. 457.
‡ Speech in the House of Lords, 23 11/08.
§ "Coast defence in relation to War." The Journal of the Royal Artillery, Vol. XXI., p. 535.

door, coast defence proper, in spite of its many weapons, will generally render no assistance.''*

General Aston, in his work on more recent amphibious wars arrives at exactly the same conclusion as Sir George Clarke, pointing out that "Port Arthur in 1894, Wei-hei-wei in 1895, Santiago in 1898, and Port Arthur again in 1904, all fell before attacks directed against the land side of their defences."†

Without pursuing this subject any further, sufficient has been said to show that, when this stage of the defence is reached, the coast defence gunner may, if he has neglected his musketry training, bitterly regret his inability to make the best use of his rifle.

It is true that we read of the activity of the shore batteries at Port Arthur as late as November, 1904. "But," says one of the defenders of the fortress, "this display cost us hundreds of precious shell which we were unable to replace."‡ And it would seem reasonable to suppose that the gunners might have been more usefully employed, especially as both the men and the guns of the fleet had been landed to assist in the defence of the land front.

Now let us examine the position of affairs when the British fleet has definitely established its superiority, and the enemy's navy has either been destroyed, or its remnants have been blockaded in some defended harbor, so that an attack on our coast defences is not only improbable but is absolutely impossible. It is then, as Colonel H. C. C. Simpson points out, that a large number of R.G.A. companies from coast fortresses will be available to accompany the expeditionary force.§

The records of the South African War, 1899-1900 bear testimony to the number of roles which the R.G.A. may be called upon to fill under such circumstances.

At the outbreak of this war there were two companies of R.G.A. and one mounted battery in South Africa. At the conclusion, in addition to the siege train and mountain batteries, eleven more companies of R.G.A. had been withdrawn fron our coast defenses to swell the army of the field.||

Again, as soon as the danger of attack from the Russian fleet had disappeared, the Japanese, in 1904, depleted many of their coast defenses of the 11-inch howitzers which so materially assisted in the reduction of Port Arthur. The gunners, thus liberated from their fortresses, set forth to take up fresh duties with the besieging army, where they might have had many opportunities of proving the value of good musketry, if they had been opposed by a more enterprising enemy.

Surely, then, there is ample justification for devoting so much time as is required to ensure full advantage being taken of the weapon with which every man in the R.G.A. is armed. The course** for gunners laid down in Musketry Regulations is not onerous. A great deal of the elementary training can be carried out in the barrack room, and at times when gun drill is impossible. In fact, the actual time lost, as far as purely technical training is concerned, will scarcely amount to a fortnight in a year; and even this is not really lost, for rifle shooting is the very best training for the eye, and a

* *ibidem*, p. 542.
† "Letters on Amphibious Wars," p. 104.
‡ "My experiences at Nan Shan and Port Arthur," by Lieut.-Gen'l. N. A. Tretyakov, p. 228.
§ The Journal of the Royal Artillery, Vol. 33, p. 460.
|| "The Boer War, 1899-1900," by Capt. L. R. Kenyon, Royal Artillery Journal, Vol. 27.
** "Musketry Regulations," Part I, Appendix II.

good rifle shot invariably makes a good layer. In fact, so good is the training for gun layers which rifle practice imparts, that the improved results in his class firing should alone fully repay a company commander for all the encouragements which he may have given to musketry. Where company rifle clubs are possible, they will be found of great assistance in stimulating men to become good shots.

If, then, we devote to musketry the attention which it deserves, our next war will find our men both more ready for any emergency which may arise in the fortress itself, and also more fitted for the duties which they will be called upon to perform, when, their work in the fortress having been accomplished, they go forth, as they undoubtedly will, to play their part with the army in the field.

—*Journal of the Royal Artillery*, January, 1912.

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THE DEFENSE OF A FORTRESS AGAINST AERIAL ATTACK

By Lieutenant J. W. Marsden, R. G. A.

The intention in the present paper is to outline the main factors that must be taken into consideration when attempting to solve the problem of the defense of a fortress against aerial attack.

In dealing with this subject at such an early stage in the application of the science of aviation to warlike purposes, we have so few reliable data to go upon that to enter into precise detail is inadvisable. For this reason, the subject is herein treated rather in the manner of suggestions of possibilities than the enunciation of definite conclusions.

We must, nevertheless, be prepared for all eventualities, however unlikely they may appear now, so that we may not be taken by surprise at the occurrence of unexpected events.

For convenience we have divided up our subject under six headings, arranged, as far as possible, in the style of an appreciation of a situation.

I. FACTORS AFFECTING THE STRATEGIC MOVEMENTS OF THE BELLIGERENTS

Disposition of the military, naval, and aerial forces.

Distances that can be traversed by aircraft.

Distances to places which could be used as bases for aerial warfare. In computing these distances the return journey may have to be borne in mind, besides the variation from the direct course due to the meteorological conditions.

Altitudes attainable.

Human endurance.

The topography, meteorology and resources of the country to be traversed by the belligerents.

The "jurisprudence of the air" (*vide* an article published in December, 1910, issue of this "Journal," by Lieutenant Leech). Legal objections to aerial operations over a given area. Here the possible attitude of other Powers must be considered, and their power to enforce the laws governing aerial warfare. This includes the possibility of damage to neutral life and property.

Command of the sea and floating halting places where the engines and personnel can be equipped for further flight.

Co-operation with friendly bases, and strategic *points d'appui.*

Increased facilities for communication, and possibly of transport, afforded by aerial locomotion.

II. OBJECTIVE TO BE ATTAINED BY THE ENEMY'S AERIAL MOVEMENTS

Reconnaissance, including observation of fire in conjunction with attack by land or sea.

Attack of:—

1. Personnel and material of the defense.
2. Stores, magazines, ships, dockyards, etc., for whose defense the fortress exists.
3. The civil population.

To attain these objects the enemy may endeavor:—

a. Unsupported aerial maneuvers; or
b. Aerial maneuvers supported by land or sea.

III. THE NATURE OF THE AERIAL VESSEL EMPLOYED BY THE ENEMY

Types of aircraft adopted by foreign powers.

Advantages and disadvantages of:—

Dirigibles.
Aeroplanes, including hydroplanes.
Balloons, free and captive.
Kites.

Their capabilities as to:—

Weight, carrying, stability, radius of action, speed, invulnerability, handiness, time and length of flight, altitude, discharge of projectiles; and their behavior in adverse weather.

The relative cost of these vessels. Their means of communication with each other and with the earth.

IV. MEANS SUITABLE FOR AN ATTACK

Meteorological conditions in the theatre of war and in the locality of the fortress.

Effect of low lying clouds. Observation of fire by vessels on a flank and clear of the cloud.

Wind.

Probable time of attack by day and night.

V. MEANS OF DEFENSE AGAINST AERIAL ATTACK

Offensive—Defensive. Probably the first line of defense, an aerial equipment supported as a second line of defense by artillery.

Role of aerial equipment for the defense:—

1. Reconnaissance.
2. Attack.

The aerial equipment for the defense includes:—

1. Dirigibles.
2. Aeroplanes, including hydroplanes.
3. Balloons.
4. Kites.
5. Aerial torpedoes and mines.
6. Apparatus for producing electrical and atmospheric disturbances.

7. Storage; gas producing plant; fitting and repariing shops; starting and "landing" places on sea and land; bomb proof cover for the above.

The amount of aerial equipment required will depend upon the building programme of other nations, and the "Power Standard" considered necessary for us to maintain.

Anti-aerial armament and accessories:—

1. Guns.—Nature of mounting to give high angles of elevation, wide arc of fire, rapid fire and traverse, small recoil.—High muzzle velocity.—Probably a 4-inch or 4.7-inch gun will best answer the requirements.

2. Projectiles.—A suitable shell constructed with a tracer and a suitable fuze. Consider risk of injury to friendly troops and territory. Fitting of safety stops requires careful selection of siting for guns so as to allow no "dead" air spaces.

Effects of:—

a. A modified shrapnel shell,

b. High explosive shell,

c. Incendiary shell,

on personnel, materiel, and stability of attacking aircraft.

All three natures of shell would be affective against dirigibles. For the attack of aeroplanes high explosive would affect the stability, and shrapnel would be effective against the personnel. A percussion fuze would not take effect until the projectile had passed through the machine, unless a lucky hit were obtained. The modified form of shrapnel would contain steel rods, or some form of chain shot, or explosive darts, or movable arms attached to the shell.

Perhaps percussion fuzes against dirigibles and time fuzes against aeroplanes.

Rockets.

Automatic fuze setters.

Moral effect on aviator.

3. Siting of batteries.—Selection and preparation of positions, consider high ground in or near the fortress. Fixed or movable mountings. Number of guns per battery, whether singly or in groups. Twin mountings. Total number of guns required for the defense.

Ranging. Finding length of fuze.

Observation of fire.

Fire tactics, scheme for distribution of fire.

4. Rangefinding, accurate and rapid, probably the "one man pattern."—To find horizontal as well as vertical distance.

Automatic sight.

"Setting" which involves great expenditure of ammunition. Speed of target and rate of fire possible.

5. Searchlights.—Concentrated and dispersed beams. Illuminated areas and sentry beams. Range of lights under varying conditions of atmosphere. Siting of beams to produce maximum effect without interfering with the anti-torpedo boat defenses.

6. Infantry fire.

7. Identification and safety of friendly vessels.

8. Adaptation of present means of defense pending issue of special equipment.

VI. PROTECTION

Overhead cover.

Subterranean storage.

Concealment of works of defense, stores, etc., by paint, screens, vegetation, etc.

Dispersion of works of defense, stores, etc.

—*Journal of the Royal Artillery*, December, 1911.

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TARGET PRACTICE

How Our Men are Taught to Shoot Straight in Rough Weather

By Lieut.-Commander Leigh C. Palmer, U. S. N., Director of Target Practice and Engineering Competitions.

A sailor's preparation for battle begins the moment he comes aboard ship. Within half an hour of his arrival, he has been given a station at a gun, with some of the older sailors to instruct him in his duties. The new recruit is first tried at aiming drill with a rifle, to see if there are any personal errors that are likely to disqualify him from the start. If he passes this preliminary step, he is taken immediately to the mechanical instruments, "dotter" and "Morris tube," and is directed to aim at a stationary target. An officer supervises this exercise, and after two or three days' work at a stationary target, the recruit is exercised at a moving target so as to develop his skill in controlling the electrical elevating and training gear in any kind of a seaway that may be encountered in "action." He actually operates the elevating and training gear of the gun he will handle in battle, so that his education is practical from the start.

It is easy enough to develop gun pointers to fire from a stationary platform, or to fire in smooth water from a ship under way. As soon as the elements of roll and pitch are brought in, however, an entirely different kind of training is necessary, and it is found that a man who is expert in smooth water may be of no use whatever when firing from a platform, whose motion is as irregular as that of a ship in a moderate sea.

In order that no time may be lost by training gun pointers under smooth water conditions, the motion of the mechanical "dotter" is made to simulate, as nearly as possible, the motion of the ship in a seaway, so that the man may not be deprived of this training, should the ship be alongside the dock or in a navy yard for urgent repairs.

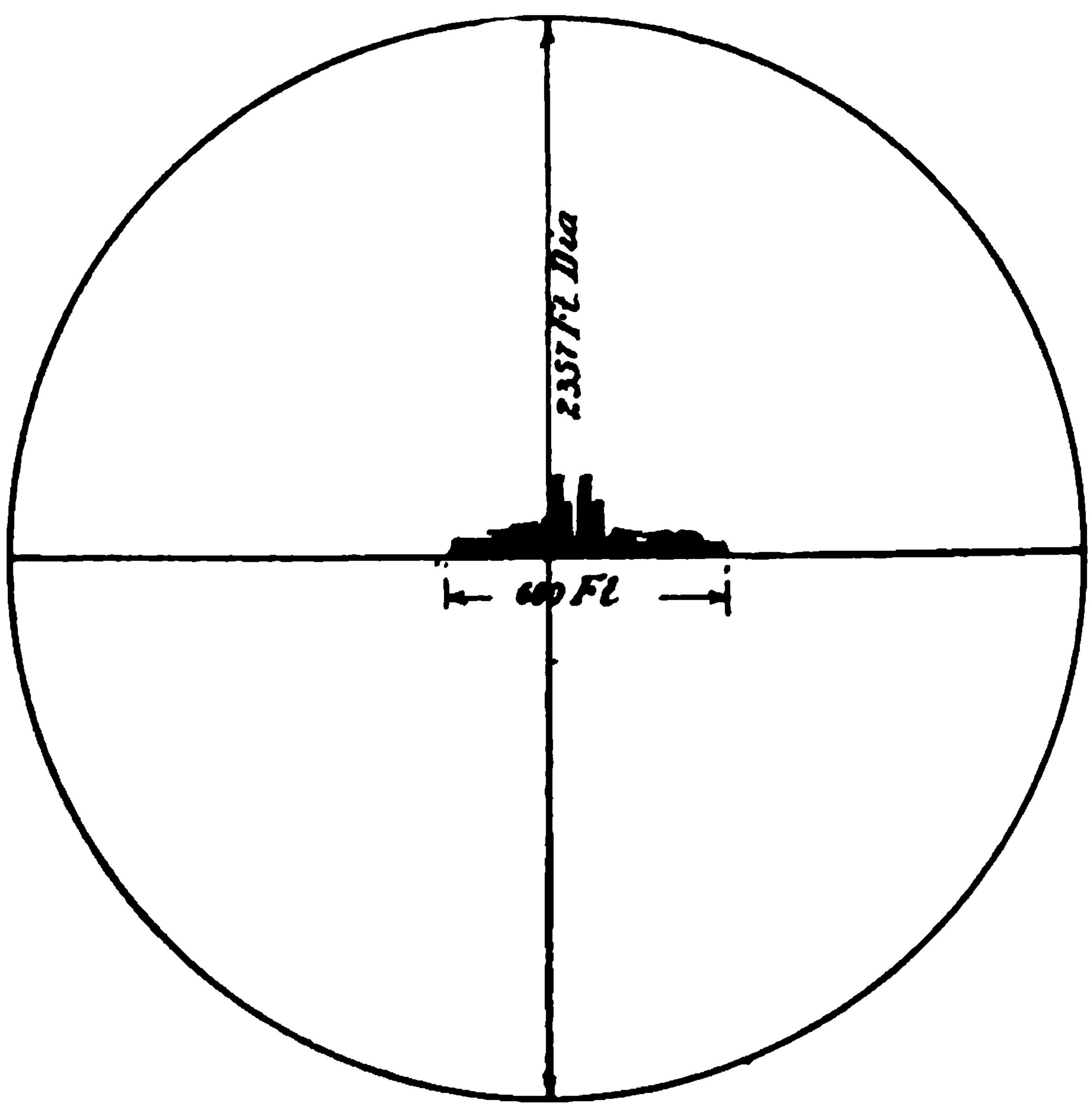
The "dotter" is an electrically controlled instrument, so constructed that the target, a miniature ship, will have the same motion with reference to the pointer's eye as an enemy's ship would have if viewed from one of our vessels steaming at high speed in a heavy sea. When the cross wires of the pointer's telescope are exactly on the center of the target, the gun-firing key should be pressed, causing an electrically operated pencil to make a dot on the target sheet. The target being in motion both vertically and horizontally, the pointer's skill is gaged by the rapidity and accuracy with which he places his "dots" when aiming at the center of the target. The "Morris tube" is a somewhat similar instrument, with the exception that a small rifle attached to the heavy gun is fired electrically and sends its bullet through the target sheet.

HEAVY WEATHER IN THE NORTH ATLANTIC.

Scientific American.

The Navy Department has issued a general order that gun-pointers shall be trained throughout the year several times each week, so that, no matter on what duty engaged or in what country the ship may be, guns' crews will be in such efficient condition that they can engage in action at a moments' notice. This order has had a very far-reaching effect; for it keeps the whole personnel and material of the ships up to the highest standard of efficiency at all times.

When the gun-pointers have been trained so that they can follow a rapidly-moving target and make hits with great skill, they are taught to fire on signal, so that the whole broadsides may be fired at the same instant. This requires unusual concentration on their part and a most intimate knowledge of the electrical gear by which the guns are controlled. The pointers are required to fire within a second after the firing signal is given;



Appearance of Battleship at 10,000 yards, as seen through gun-sight telescope

and when it is remembered that they operate the controlling [illegible] enormous [illegible] them follow [illegible] can well be [illegible]

During [illegible] crews, the [illegible] the men [illegible] men who [illegible] petitively [illegible]

It is [illegible] markable [illegible] in comp[illegible]

tice or at the end of the year's gunnery work, they receive their rewards in trophies, letters of commendation, and gunnery "E's," which last may be worn only by men of winning gun or turret crews as a special mark of efficiency.

No detail of the training is too small to be given the undivided attention of the officer in charge. The apparently simple motion of setting the sights for each new range has to be watched from day to day, by giving numerous sets of ranges to several men in competition, and noting the rapidity and accuracy with which each accomplishes the work assigned him.

The men who open the heavy breech-plugs, one-half ton in weight, do so wholly by hand-power, as it is found to be as rapid and more reliable than any mechanical means. Even in this particular work the men are placed

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PRIZE WINNING CREW OF U. S. S. "MICHIGAN."

This crew in No. 3 turret made the highest score on Southern Drill Grounds in the spring battle practice in 1911.

in competition; for the officer stands by with his stopwatch and starts two plugmen at the same instant withdrawing their plugs, noting the time when each has completed his work. With skilled plugmen this varies from 2¾ seconds to 3 seconds for 12-inch guns, and the slower plugmen are given other work requiring less speed and strength.

Every step of the drill is carefully worked out before any two steps are combined. All the men are tried out to see which ones will make the best powder passers, and as this is very trying work during a protracted engagement, only the strongest and most active men are selected dor this duty.

The men who ram home the enormous projectiles, weighing 870 pounds, require a great deal of drill, for a slight error of a fifth of a second in applying the necessary force to seat them may well cause the loss of 3 or 4 seconds

in the complete load. As it is necessary to deliver the greatest number of hits in the shortest possible time after the enemy is sighted, it will be seen how vital it is that not a fraction of a second should be lost in any of the details of loading or firing. It may happen well in a naval duel between two battleships that one of them will be put out of action within five minutes after the first shot is fired.

Although to the casual observer of the daily competitive drills there appears only the keen sportsman's instinct to win, there is also a grim feeling that some day the national honor may depend upon the saving of a few seconds, enabling us to deliver a broadside of highly destructive projectiles into the vital parts of an enemy at a critical moment.

The character of the enlisted force of the service has changed remarkably in the last 15 years. There is a community of interest between the officers

Scientific American.

WATCHING FALL OF SHOTS FROM TOWING SHIP "MICHIGAN."

This is the splash of 7-inch shells of "Connecticut" fired at 7000 yards range.

and men. The reasons for every order are fully explained, so that the men are thoroughly familiar with the object sought and with the material used. This applies not only to loading and firing the guns but to the whole fire-control and range-finding system, so that when a naval battle is fought, intelligent petty officers may take the place of officers who are killed or disabled. The whole service is working together with one end in view, that of efficiency in battle.

A recent order of the Navy Department calls for carrying out the drills with guns and fire-control parties during rain, snow and heavy weather generally, so that our men may be prepared for the most adverse weather conditions to be encountered "in action." Crews drilled in smooth water

only and in fair weather are worthless when firing in rough weather in the open seas.

After the training with the mechanical targets on board ship is completed and after the loading crews are well instructed, a certain amount of ammunition is provided to fire the guns under the same conditions as would obtain "in action," so that the officers may find out definitely whether or not any particular pointer is "gun shy." During this practice a target is used on which the hits are recorded, or photographic records are kept, so that the final efficiency of the gun-pointer is obtained while the guns are actually firing. Should a pointer show any evidence of being "gun shy," he is immediately dismissed from the gun crew. The training from now on is a co-ordination of all the units, that is of all the gun crews and fire-control parties, so that when the day comes for the final test of the ship at battle practice in heavy weather, the team work will show how faithfully the individual operations have been performed.

Scientific American.

REMOVING NET SCREEN FROM TARGET.

Men of the "North Dakota" on the target raft removing the net for examination

At battle practice the conditions are made just as severe as those that would obtain in actual "action." The firing vessel has no knowledge of the course, speed, or distance of the target vessel. All the information she has is that somewhere on the horizon at a distance of 10 miles or more is a column of smoke which marks the enemy at which she is to shoot. She steams toward it at her best speed and opens fire at whatever range she chooses, but the value of hitting at long ranges is vitally impressed on her by the amount which is added to or subtracted from her score for the shots that

FORWARD TURRET OF THE U. S. BATTLESHIP "MINNESOTA."

Above the 12-inch guns is the Morris tube and mechanism used in training gun-pointers.

hit beyond 12,000 yards or under that mark. The whole firing is finished in four minutes and she has no other chance to make good if she has failed in this. No excuses are accepted for failure of guns to fire, for breaking down of any gear, or for any faults of the personnel or material. The instant the target is sighted, the firing vessel must steam toward it at high speed and deliver her salvos in the shortest possible time.

Part of the most important training is that given to the "spotters," both officers and men. These are detailed in accordance with their skill at estimating distances at which the projectiles fall short or over the target at ranges of from 10,000 to 13,000 yards in the open sea. They must show a very high degree of skill, for on their accurate judgment and their cool heads during battle, depend the life of the Fleet and of the Nation. They are trained daily at "spotting boards," and at these drills the most skillful are selected to be further trained at the spotting practices, where actual projectiles are used against an armored target. At the recent spotting practice against the *San Marcos* in Chesapeake Bay it was found that salvos of eight projectiles fired at a distance of 11,500 yards could be placed on any part of the target ship.

Though the gun pointers and the gun crews are perfect, their skill is of little value if the fire-control parties are not sufficiently well trained to estimate the proper errors in range and bring the center of impact of all projectiles on the target. The demonstration against the *San Marcos* (ex-*Texas*) was one of the most remarkable exhibitions of team work ever shown in the Navy. The theoretical number of possible hits at that range, if all conditions of temperature, atmosphere, steadiness of platform, skill of gun pointers, etc., were perfect, was 43 per cent. The detailed examination made by the special board showed definite evidence of 33 per cent. of hits, the board further stating that so much of the ship was shot away, it might well be that many other projectiles hit the *San Marcos* without leaving a definite record.

The prizes for gunnery work on elementary practice are of little value, and in the annual battle practice each year, where the keenest interest is displayed by every officer and man in the fleet, the only reward is a little piece of red bunting with a black ball in the center, floating proudly at the mast head of the winning ship.—*Scientific American*, December 9, 1911.

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SOME DUTIES OF THE ROYAL GARRISON ARTILLERY IN WAR

By Captain M. H. C. Bird, R. G. A.

It may be asked: "What need is there to discuss the duties of the Royal Garrison Artillery in war more than those of any other arm? It is an arm very much apart from the rest of the Army, so much so, that some of its members openly advocate handing it over to the Admiralty; its work has but little connection with that of the Army at large, and cannot be of great interest to it."

It is hoped that the following pages may show the need for such a discussion, and for some more definite steps being taken towards the preparation of the Royal Garrison Artillery for a part of its work which does not hitherto appear to have received all the attention which it deserves.

There are, at home and abroad (exclusive of India, which is not considered in this paper), the following units:—

34 garrison companies at home.
48 garrison companies (British) abroad.
3 siege companies at home.
6 heavy batteries at home.

The duties of the 85 companies on the Imperial Establishment appear, to the casual observer, to be summed up in the following extract from Field Service Regulations, Part I, Section 4 (9 and 10): "Siege artillery brigades may be allotted to the field army for special duties in connection with fortress operations. Garrison artillery companies are allotted to coast defenses." Further investigation, however, indicates that the matter is not so simple as the above extract would lead one to believe. Chapter VIII, Field Service Regulations, deals with siege operations, and it is a matter for congratulation that this branch of warfare has been included in a training manual that is the common property of all arms of the service. Here we find, in Section 124 (1 and 6), the following references to technical branches:—

"The composition and strength of a force destined to undertake a regular siege must be adapted to the special work required of it. The proportion of cavalry may be less than in the field army, while that of artillery and engineers must be largely increased.

"In the case of the artillery, the increase is effected by adding to the normal establishment of a field army a certain number of siege artillery units. This number will be determined by the requirements of each case."

"The duties of the technical branches of the service in siege warfare, which come more particularly into play during the advance on the front of attack from the line of investment to the position from which the assault is to be delivered, are dealt with in 'Garrison Artillery Training, Vol. II,' and 'Military Engineering, Part II.' "

But Garrison Artillery Training is not a book that officers of other arms are likely to dip into. It gives the available force of siege artillery as follows:—

Page 1.—"(1) Siege batteries will not normally form a part of an army in the field, but will, if required, be added as circumstances may demand.

"(2) The peace establishment of siege artillery comprises a siege artillery brigade of three garrison artillery companies, two of which are equipped with medium howitzers and one with heavy howitzers.

"Each of the three companies forms the nucleus of two batteries which are organized for war as:

"A heavy brigade of two heavy howitzer batteries.

"A medium brigade of four medium howitzer batteries and two ammunition columns."

This organization provides a force of eight heavy and sixteen medium howitzers, and it would be reasonable to assume that they could and would be mobilized with, or directly after, the Expeditionary Force, and would be available as soon as required. One might also suppose that this quantity would suffice to meet all possible needs, and it would be hardly worth while to bother much about the special duties of an arm amounting to only 24 pieces but for the following paragraph: Garrison Artillery Training, Vol. II, p.2 (3): "The siege artillery may also be augmented by additional batteries, of heavy

guns, and by other medium howitzer batteries, manned by personnel detailed from the garrison artillery companies." This arouses a faint suspicion in the mind of the reader that the two siege brigades may not always be quite enough. There is also a remark in Field Service Regulations, Part I, Section 124 (4) iv, about "immense stores."

One gathers from all this that some increase in the siege artillery brigades may possibly be required ,and that a quantity of stores, of unspecified nature but "immense," will have to be brought up. What is not at all evident is that the increase may be from five to ten times the strength of the original two brigades, and that the stores required may amount to 1,400 tons daily, or more, for siege artillery ammunition alone.

As so startling an interpretation of the paragraphs quoted from our various regulations requires some support, some historical instances will be given, as well as the results of modern continental investigation and of siege staff tours held in England in recent years.

The following statement shows the nature and number of the ordnance employed in 1870: –

Strassburg (Original Siege Train)

Heavy S.B. Mortars and 6-inch guns	108
" " 4.7-inch guns	100
Light S.B. mortars and 3.5-inch guns	80
Total	288

Paris (Original Siege Train)

Rifled guns, 8-inch and over	6	
" 6-inch	59	
" 4.7-inch	84	
" 3.5-inch	40	
" 6-inch howitzers	15	(new pieces)
Smooth bore Mortars	20	
" Shell guns	20	(useless)
Total	244	

Paris (North Front, attacked later)

Guns, 8-inch and over	3
" 6-inch	36
" 4.7-inch	16
Howitzers, 6-inch	18
Total	103 all rifled.

The following table gives the Japanese siege train at Port Arthur:—

	22/8/04.	Changed by 2/1/05.	Total.
Naval guns, 6-inch	0	+ 4	4
" " 4.7-inch	6	+ 4	10
" " 12-pr	18	+ 9	27
Bronze guns, 4.7-inch	30	0	30
Krupp guns, 4.2-inch	4	0	4
Howitzers, 6-inch	16	0	16
" 4.7-inch	28	− 8	20
" 3.5-inch	24	0	24
" 11-inch	0	+18	18
Mortars, 6-inch	72	0	72
Total	198	....	225

The land front of Port Arthur was short (only 12 miles) compared to the perimeter of modern Continental fortresses, and the foreground lent itself well to the establishment of siege batteries in concealed positions. The defenses were of weak construction, without armor, and far more conspicuous than is usually the case, and the Russians had no heavy howitzers to speak of with which to meet the Japanese siege artillery. And yet the 225 pieces which the Japanese employed, in addition to their field artillery, only just sufficed.

Some years ago two Austrian officers, Macalik and Langer, brought out a book entitled "Der Kampf um Guertelfestungen," in which the requirements in guns, ammunition, personnel, and transport were most carefully worked out. Their estimate of what would be needed for the attack of a modern fortress may be summarized as follows:—

Mobile Siege Artillery, brought up with the Siege Army, corresponding to our Medium Brigade (6-inch Howitzers)	60
Siege Ordnance (not mobile), 4.7-inch guns	32
" " 6-inch guns	48
" " 6-inch howitzers	192
" " 9.45-inch mortars	48
Total	380

The transport required to bring up this siege train complete with its first provision of ammunition, horse transport, artillery personnel, laborers, and three railway companies, was estimated at 79 trains of 100 axles each; for the second provision of ammunition, 25 more trains were needed; while it was considered that an adequate rate of fire could be maintained only by the whole of the 380 guns and howitzers if seven train loads of ammunition were brought up daily.

In 1907 a siege staff tour was held at Shoeburyness, in which 92 guns and howitzers of various sorts were employed. The first supply of ammunition was estimated at 1,500 tons, and the daily requirements at 1,000 tons.

A second siege staff tour was held in 1908, when the number of guns was 168; the weight of the first supply of ammunition, 250 rounds per piece, irrespective of its nature, amounted to 3,000 tons, and with an average rate of fire of only 5 rounds per piece per hour the daily requirements worked out to 1,500 tons.

So much for the stores.

The strength of the Japanese siege artillery is not given in Part III of the "Official History of the Russo-Japanese War," but the 225 guns could have been manned by 28 of our heavy brigades, or say 392 officers and 11,172 men.

In the scheme worked out by Macalik and Langer it is estimated that each "Group" of 4 batteries (*i. e.*, 16 pieces) will be manned by 1 battalion of 5 companies (including 1 for park duties), each company having a strength of 4 officers and 170 men. In addition, each battalion would presumably have a staff of, say, 2 officers and 10 men, and as the battalions are grouped in regiments of 2 battalions, similar staffs will be needed for them also. There being 10 "Groups," there are 20 battalions or 100 companies, equal 400 officers and 17,000 men, 30 regimental and batallion staffs equal 60 officers and 300 men, making a total of 460 officers and 17,300 men.

In the 1907 staff tour the siege train was organized in 6 brigades, besides 3 heavy field artillery brigades; 4 of these had 16, 6-inch howitzers each, and might therefore be classed as medium brigades. But according to present War Establishments, and the extracts already given, it is probable that only one of them would be so organized, the remainder being organized on the same lines as the heavy brigades. According to War Establishments and Garrison Artillery Training, Vol. II, a heavy brigade only mans 2 batteries or 8 guns, whilst a medium brigade mans 4 batteries or 16 guns; the requirements for this staff tour therefore work out as under:

1 medium brigade 1 heavy brigade	already provided for
6 brigades of 6-inch howitzers and 1 heavy brigade	*i.e.*, 7 brigades, organized as heavy brigades, to be found by R.G.A.

In the 1908 staff tour there were 6 heavy brigades and 6 brigades of 6-inch howitzers (16 each). Calculating on the same lines as for the 1907 tour the requirements were:—

1 medium brigade 1 heavy brigade	already provided for
10 brigades of 6-inch howitzers and 5 heavy brigades	*i.e.*, 15 brigades, organized as heavy brigades, to be found by the R.G.A.

The following table gives a recapitulation of the most recent practical and theoretical experience:—

Occasion.	Guns.	Officers and Men.	Remarks.
Port Arthur	225	28 brigades = 11,564	
Macalik and Langer	380	17,760 = 44 brigades (about)	104 trains for men and stores, including second supply of ammunition. 7 trains daily.
1907 Staff Tour	92	7 brigades = 2,891	First supply 1,500 tons, 1,000 tons daily.
1908 Staff Tour	168	15 brigades = 5,985	First supply 3,000 tons, 1,500 tons daily.

It should be noted, however, in connection with the two staff tours that according to Garrison Artillery Training, Vol. II, p. 156, par. 11, special arrangements for the ammunition details of the heavy brigades will have to be made on mobilization, which would, on the basis of Macalik and Langer's calculations, amount to an extra 800 men for the 1907 tour, and 1,200 men for that of 1908.

RESOURCES AVAILABLE

To meet our immediate requirements of two siege brigades we have in England a siege brigade with a peace establishment of 20 officers and 582 non-commissioned officers and men. Its war establishment being 46 officers and 1,562 non-commissioned officers and men (without attached), there are 26 officers and 980 non-commissioned officers and men to be found on mobilization.

With 8 years' color service it may be assumed that 73 men join the Reserve annually, and with 4 years' reserve service, and allowing for 5 per cent. waste per annum, the strength of the reserve supplied by the siege brigade serving at home cannot be much more than 270, leaving 710 to be be provided from other sources. A certain number of men belonging to the garrison companies at home are put through a course of siege work at Lydd annually, but these are selected men, and establishments in coast defenses being what they are, it is conceivable they could not be spared to join the siege batteries.

There are, however, in India, 6 heavy batteries and 2 siege companies, with a total establishment of 822, which may be taken as providing a reserve of 380, calculated as above. Supposing that this is not wanted for India, it would be available to fill up the home siege brigade, leaving a deficiency of 330, but a considerable number of the garrison companies in India are trained as heavy batteries, and many of those in the colonies are trained to work the movable armament, consisting of heavy field guns and howitzers and it seems probable that the reservists supplied by these would suffice to make up the remaining 330 required.

The successful mobilization of the two siege brigades required for first use appears therefore to depend ,as far as non-commissioned officers and men are concerned, upon the arrangements made by the Royal Artillery Record

Office for keeping careful lists of the reservists from siege and heavy companies and for recording their qualifications as layers, telephonists, and observers, in considerable detail. If this is done, the addition of 170 per cent. to the peace establishment must cause extraordinary confusion.

The 26 officers will have to be found from the Royal Garrison Artillery companies at home, which will cause considerable strain. A number of them also, are put through siege courses every year, but owing to the annual reliefs in addition to continual changes caused by promotion, etc., it must be difficult to keep the lists of trained officers up to date. On the outbreak of war, all the available officers will be urgently needed in the coast defenses, for which they only just suffice as it is; the supplementary list of the Special Reserve hardly exists as yet, even in the Army List, and there are no special Special Reserve units of Royal Garrison Artillery available to draw from, those in Ireland being already told off to coast defenses. How soon the Territorial officers would be fit to take the place of Regulars it is hard to say, and it seems unlikely that they could easily be spared.

For any augmentation of the siege artillery first sent out the Royal Garrison Artillery companies at home must be drawn on, as laid down in regulations already quoted. The non-commissioned officers and men on the peace establishment of companies at home and in the reserve, but exclusive of the six heavy batteries, the siege brigades, and the reservists required for them, amount to some 9,000 odd, or enough for some 23 heavy brigades, but the number of officers is apparently only just enough for 15. This leaves nothing over for extra requirements on the lines of communication, or at the advanced base, which would almost certainly be necessary to help with the large quantities of extra stores.

To carry out a siege of only moderate dimensions would, therefore, use up the whole of the Garrison Artillery at home, and would leave no reserve behind to fill up casualties.

NEED FOR PREPARATION FOR SIEGE WORK

Before inquiring into the nature and extent of the preparation given to and required by the Royal Garrison Artillery to fit it to undertake the task outlined above, it seems desirable to meet the possible objection that such duties are never likely to be required of it, and that therefore no preparation is necessary.

In the first place, the mere fact that a chapter on siege operations is included in the Field Service Regulations, shows that those responsible for the training of the Army in peace, and for its employment in war, consider it possible that it may have to take part in them, and therefore intend that all officers shall make themselves acquainted with their special characteristics.

Any campaign on the continent of Europe would probably involve siege operations on a considerable scale, for the purpose of securing river crossings, opening railway lines, protecting the lines of communication against interference, guarding one's own flank, or threatening that of the enemy.

That a siege, when once it is decided upon, must be pushed with energy and not be allowed to drag on, may be a truism, but the principle cannot be acted on unless adequate preparation is made. Both in 1870, and in the Russo-Japanese War, the dangers that arise through insufficient preparation for siege operations were made manifest again and again.

It may be that a siege may not be quite to our taste, and that any success we may attain in that direction will not bring in so much glory as operations in the field. But circumstances may compel us to undertake a siege, and we should be ready to do so.

PRESENT PREPARATION AND SUGGESTIONS FOR IMPROVEMENT

The amount of preparation which the Royal Garrison Artillery undergoes to fit it for siege operations is perhaps more than is generally realized, although in various ways it might be made more thorough and more definite in intention. Garrison Artillery Training, Vol. I, Section 12, lays down that all companies must be trained with movable armament and instructed in siege artillery methods. In Section 7 it is stated that officers undergo courses in siege work at Lydd. Section 5 insists on the need for training officers for duties when serving with an army in the field, in movable armament, and in siege artillery methods, and it further directs that they shall be given reconnaissance work in connection with the employment of the guns of the movable armament.

The instructions for practice, Royal Garrison Artillery, lay down certain practices to be carried out by Royal Garrison Artillery companies that are allotted to movable armament on mobilization, and, so far as is known without looking into defense schemes, most, if not all, of the companies stationed abroad are trained with movable armament, consisting of howitzers, heavy guns, or field guns. Indeed, so well is it recognized that the coast defenses have in the past, as a rule, succumbed to land attack only, that the thoroughness of the training, and the efficiency of the companies, has steadily increased from year to year.

It is also unfortunate that, in some stations, conditions of ground and space are such as to render training very difficult, whilst practice has often to be carried out at targets in the sea. This last condition is, in some cases, impossible to rectify, but it need hardly be pointed out how much is lost by it.

It is evident, therefore, that the proficiency of the Royal Garrison Artillery in siege work is a very variable quantity, and is apparently at its lowest in the companies stationed at home—the very ones that will have to be used to form the siege train when we require it.

These defects might be minimized, to a great extent, by increasing the allowance of ammunition, and by making all companies practice with movable armament, whether talloted to it on mobilization or not, Land ranges, especially for long range guns like 4.7-inch, are difficult to find, but something would be gained if practice could ce barried out across bays and inlets on to uninhabited promontories, or even islands, instead of at targets floating in the sea, a proceeding for which neither the ordnance nor the instruments used with it are designed. What could be done in this way can, of course, only be discovered by reconnaissance on the spot. It might also be possible to get people to move out for one day at a time, without incurring too heavy a charge for compensation, and so avoid the prohibitive expense of buying, or even hiring, land ranges near every fortress, or the need for sending many companies to distant and overcrowded practice camps by rail.

It is suggested that a section should be inserted in Garrison Artillery Training pointing out that should the Expeditionary Force be dispatched abroad, it probably would be necessary to undertake siege operations in-

volving the employment of the bulk of the Royal Garrison Artillery stationed at home; that it is imperative that the Royal Garrison Artillery should be prepared to undertake the working of the siege train required for this purpose; and that, therefore, all companies must be trained to siege work as a duty second only in importance to coast defense.

The division of the regiment into field and garrison branches was essential to the efficiency of the garrison branch, and, in that respect, has proved its soundness up to the hilt—but the Royal Garrison Artillery has suffered from the defensive spirit ever since. It spends its time waiting for an enemy who may never come, whose coming, indeed, the defenses are expressly designed to prevent, and who, therefore, very likely never will come unless reasons of strategy compel him, as with the Japanese at Port Arthur. Troops trained in such an atmosphere are bound to deteriorate; and the monotony of looking at and shooting into the same patch of sea for five years on end, with nothing else to look forward to, needs to be experienced before it can be fully realized. The prospect of going out to look for the enemy, if he will not come to you, is necessary to stimulate keenness and hope.

In the matter of organization also, the defensive idea predominates, to the complete exclusion of any other.. The present system, according to which reliefs are carried out by drafts, instead of whole companies, and the companies are of varying establishments, was devised to meet the difficulties caused by the arrival in a station of new companies which were complete strangers to it, and by the different strengths required to suit local conditions. The advantages are, of course, obvious, but they benefit and tend to emphasize the defensive side of Royal Garrison Artillery work only. The companies have become entirely sedentary, with nothing at all to hint at any offensive role. Other disadvantages which have followed from an excessive extension of localization, in some cases, actually unavoidable consequences of it, hardly come within the scope of this paper, and can be remedied by those responsible for the training of the Royal Garrison Artil lery. For siege work, units must be of equal strength, since they each man the same number of guns. This can be arranged by varying the number of reservists allotted to each, whilst a few specially strong companies may have to hand over complete sections to the weakest, to prevent them being utterly swamped by reservists. This is clear from the fact that peace establishments at home vary from 92 to 236 of all ranks. It is suggested that some readjustment might be possible without excessive expense; it is an important matter, since, without a certain establishment, the necessary specialists, who need continuous training and practice in ever-changing methods, cannot be maintained. No further changes in the present organization of Royal Garrison Artillery companies seem essential.

In order to overcome the difficulty of finding the extra officers required for the existing siege brigade, it is suggested that the lieutenant-colonel commanding should be made responsible for obtaining supplementary Special Reserve officers for it; at present, it is nobody's business, as coast defense commanders, who are now responsible, will naturally try to get officers for coast defense work, and the siege companies are not under them except to a limited extent. As it is, the Army List at present only contains the names of 16 supplementary reserve officers all told. It would also appear desirable to raise the peace establishment of the siege companies, as an

influx of 170 per cent. of reservists is more than any unit can stand without a good deal of disturbance.

In order to increase the number of Royal Garrison Artillery available, so as to be able to replace casualties, and to undertake a siege of more considerable dimensions than is now possible, Section D of the Army Reserve might be thrown open to the Royal Garrison Artillery to a greater extent than it is. The work required can be performed by older men than is perhaps desirable as infantry reservists. Another 3,000 would put the siege train on a fairly satisfactory footing. What is more important, however, is the supply of officers, and no effort should be spared to obtain supplementary Special Reserve officers, as long as the requirements of the field army are not unduly interfered with.

It is further suggested that a new section should be added to Field Service Regulations, Chapter VIII, discussing the influence of fortresses on field operations, the reasons why they exist, and the circumstances which may consequently render their capture necessary. It is submitted that, if other objects besides the one mentioned in Section 116 (2) for the construction of fortresses were set forth, it would make it plain that the question of attacking them is very much less a matter of choice than the chapter, in its present form, would lead one to suppose.

Finally, in this connection, it is desirable that siege staff tours should not be left entirely to the technical branches of the service. The inclusion of Chapter VIII is a step in the right direction, the necessity for which is abundantly proved by the events of 1870 and the Russo-Japanese War. The next step should be to bring siege staff tours into intimate connection with field operations by introducing them into the scope of staff tours on a large scale, or Army maneuvers. In any case, after due general consideration of the technical problems involved, the General Staff should undertake the conduct of siege staff tours themselves, leaving to the technical branches only the actual technical details of the work. In this way we shall arrive at a clearer idea of the problems that may confront us, and have a fair chance of coming to a satisfactory conclusion as to the extent to which our preparations for siege warfare should go.—*Army Review*, January, 1912.

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THE FRENCH MOUNTAIN GUN DEPORT SYSTEM

Translated from the *Revue Militaire Suisse*, May, 1911

By Captain C. O. C. Hunt, R. F. A.

This new equipment is distinguished by the fact that a forward movement is given to the gun before the charge is exploded and this movement is still in progress at the moment of firing, and thus acts against and so diminishes the force of recoil. This enables the length of recoil to be reduced.

This principle has been called differential, reduced, or shortened recoil; but be it understood that this shortening in no way reduces its ballistic qualities or its stability. The speed of the recoil movement is reduced; the movement to the rear, proportional to the force exerted is reduced to almost one quarter; thus, given the former to be 5.80 f.s., it is reduced to 1.68 f.s.

Such is essentially the principle of the new equipment.

Its Action:—

When fired, the gun, driven back by the force of the explosion, recoils, and acts upon a recuperator brake which deadens its movement to the rear. Having reached the extreme backward limit and the brake is about to force it forward the gun is held back; and it is in this position that it is loaded. When the gun is again to be fired the hooking apparatus holding back the gun is released. The brake asserts itself and the gun is given a movement to the front During this forward movement it strikes against a catch fixed to the carriage The blow against the projection releases the firing mechanism, and the cartridge is exploded, while the gun is still travelling forward at speed.

To fire the first round the brake (recuperator) must be first of all compresssed, to allow the gun to be brought into the loading position. This is done by means of a toothed pinion engaging with a rack fixed along under-

Fig 1

neath the gun, the pinion is actuated by a hand wheel. If a miss-fire occurs, the gun, driven forward by the brake up against the stops, would be brought up with a shock and would be liable to upset. To obviate this, two buffers are provided.

Description:—

The gun is of forged steel, caliber 65 mm. (2.565-inches). Length 1m. 11c. (43.53-inches) *i. e.*, 17 calibers.

In front are three projections which fit into a ring round the muzzle like a bayonet. This ring is prolonged by an overlap which covers the brake and also the cradle in which the gun slides backwards and forwards.

The brake consists of a double spiral spring the rear end butting up against the cradle; it surrounds the gun and is enclosed by the overlap of the

muzzle ring, on which it bears. (In Fig. 1 the spring is apparently uncovered, this is done for purpose of photographing; normally the helical spring is only exposed for a very short time, while the gun is recoiling and running up, and is hardly appreciable.)

The breech ring carries two brakes. These are cylindrical buffers filled with mineral jelly each fitted with a piston. These are necessary to avoid damage to the gun should a miss-fire occur.

The breech mechanism consists of an excentric actuated by a lever: a quarter of a turn opens the breech.

The firing mechanism fixed to the breech is so arranged that an arm strikes against a projection on the cradle and fires the gun.

A double spring bolt carried by the cradle acts when the gun reaches its maximum recoil and a key engages in the teeth of the rack and secures it

Fig. 2.

Having loaded the gun —laying is done simultaneously —a lever within reach of the number on the left allows of the key being disengaged; and the gun, under the influence of the spring is projected forward, which fires the round. The recoil again compresses the spring, the gun is then held back with the springs in compression and it is immediately ready for reloading.

The length of recoil is 17.25 inches, when the gun is horizontal. About 25 rounds can be fired per minute.

The carriage is of rolled steel. The trail can be folded back on its hinges in the center, this is to facilitate loading on mules.

The trail, carries a trail spade capable of sliding in a nearly perpendicular position and which is driven into the soil by means of a sledge hammer before opening fire. The gun is then immovable from the first round. (In rocky soil it is sufficient to engage the point of the spade in a fissure, even a small one).

The upper part of the brackets carry the bearings for the trunnions. Two seats are hinged to the side brackets upon which the two numbers serving the gun kneel. These seats can be folded back to allow of loading on the pack saddle.

The gun is traversed along the axletree arm, giving a field of fire of 6°.

Elevation is effected by means of a wheel placed in rear of the traversing wheel and working in a toothed arc. An angle of 10° depression and 45° elevation can be given, or a vertical field of fire of 55°.

The wheels of wood, with steel tyres are scotched by metal blocks when in action. The diameter of these wheels is 27.3″. The track is 2′ 9″.

The projectile in the form of a cartridge weighs 9,24 lbs., and 10.3 lbs. The first gives an initial velocity of 1211 f.s. with a striking force of 94.28 foot-tons; the second an initial velocity of 1065 f.s. with a striking force at 83.3 ft. tons; the charges (nitrocellulose composition) are respectively 7 and 6½ oz., the corresponding cartridges weighing 10.79 lbs. and 12.07 lbs.

Three pack animals are necessary, one for the howitzer and its breech mechanism, 236 lbs.; one for the outer case with its toothed arc, springs, etc., 258 lbs.; one for the carriage and wheels, 236 lbs.

If the gun is fitted with a shield, the weight of which is 121 lbs., this shield can be carried on a fourth animal.

Colonel Deport has succeeded in designing a mountain howitzer with a caliber of 2.95 inches for the same carraige. The howitzer is of the same weight and exterior diameter as the gun and thus fits the carriage.

It fires a projectile of 14.3 lbs. with an initial velocity of 932 f.s. The range at an elevation of 31° is 5450 yards. The remaining velocity at this range being 842 f.s.—*Journal of the Royal Artillery*, October, 1911.

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OPERATION OF INTERPOLE MOTORS

By Gordon Fox

Interpole motors are now being extensively used for variable-speed service, for high-speed operation and to handle widely fluctuating loads, nearly all of the commutation troubles previously developed by these classes of service having been eliminated by means of the interpole construction. However, the auxiliary poles add some complication to the ordinary shunt-wound machine and frequently troubles arise from misunderstanding of their exact functions. The purpose of the intermediate poles is to neutralize the effects of armature reaction and self-induction and to maintain a fixed electrical neutral point, allowing the brushes to be set permanently at one place and to effect practically sparkless commutation at all loads. In an ordinary shunt- or compound-wound motor, when the load increases, the neutral point shifts backward with respect to the direction of rotation, by reason of the magnetic reaction of the armature winding. A study of Figs. 1, 2 and 3 will help to make this clear. Fig. 1 shows approximately how the

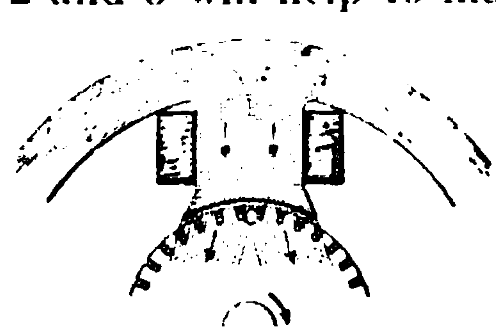

Fig. 1.

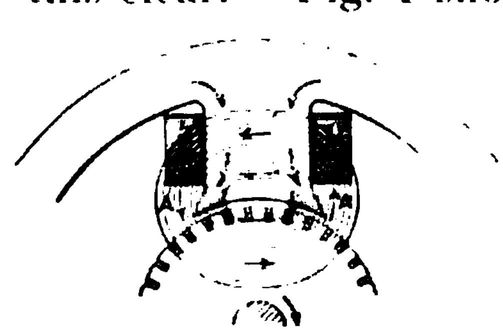

Fig. 2.

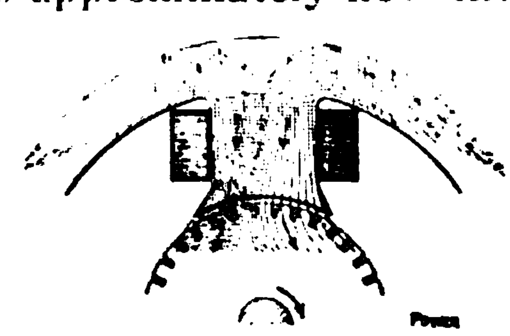

Fig. 3.

magnetic flux passes from a field-magnet "north" pole to the armature core when no current is flowing in the armature winding. Fig. 2 indicates the direction of the magnetic flux that would be produced by current in the armature winding alone. By comparing this with Fig. 1 it will be evident that the armature magnetism opposes the field magnetism in the right-hand half of the magnet pole and airgap and agrees with it in the other half; the arrows *A* give the direction of magnetic force due to the armature current and the dotted arrows show the direction of magnectic force due to the field winding when it is excited. The result is distortion of the field flux somewhat as indicated in Fig. 3. The armature magnetic force is too weak to neutralize entirely the magnetic force in the right-hand half of the pole, but it neutralizes some of it and increases the flux in the left-hand part, near the poleface, producing the same result as though the field flux had been pushed over physically.

The actual neutral point on the armature is exactly midway between the central part of the flux under one pole and the corresponding point under the neighboring pole, when the flux is evenly distributed, as in Fig. 1. When the flux is crowded more in one place than another, as in Fig. 3, the central point is near the densest part of the flux, as in *C*. Comparing Figs. 1 and 3 in this respect, it will be found that in the latter the armature reaction has shifted the central point of the flux back about 1½ armature teeth; the neutral point, therefore, will also have been shifted backward to the same extent, and brushes which were on the neutral points of the commutator when the flux was evenly distributed, as in Fig. 1, will be about 1½ bars ahead of the actual neutral points if the field becomes distorted by armature reaction as in Fig. 3. On an ordinary shunt wound machine it is common practice to set the brushes in an intermediate position between the no-load and full-load neutral points, usually at the point where commutation is best with that load which is carried most of the time.

In a properly adjusted interpole motor the neutral point remains fixed, regardless of the load. With the brushes properly set the motor should be reversible and show the same speed characteristics in both directions; this is a good criterion as to the correctness of the brush position. The polarity of the interpole is the same as the polarity of the preceding main pole. If the interpole is too strong or if the brushes are given a backward lead, the main field flux will be partially neutralized and the result is much the same as though the field had been weakened; the resultant commutating points will be shifted away from the brushes and the motor will probably race, because of the reduced counter electromotive force at the brushes. This will be caused by excessive interpole magnetism only with considerable load,

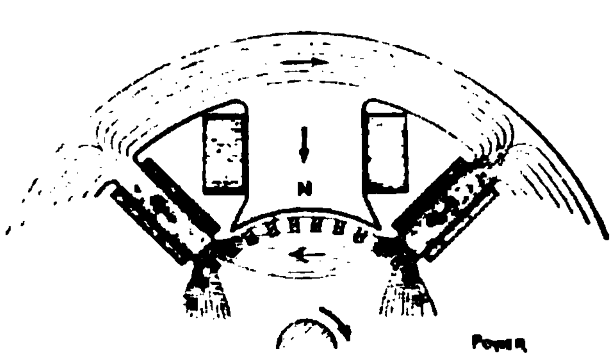

FIG. 4. Interpole flux alone.

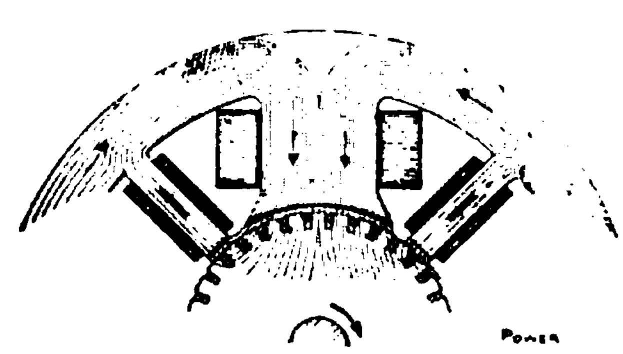

FIG. 5. Combined fluxes.

because the interpoles are magnetized by the armature current and their strength depends on the load. Fig. 4 shows the interpole flux alone and

comparison with Fig. 2 will show that it is opposed to the magnetic forces of the armature winding. Fig. 5 shows the main and interpole fluxes combined.

From the foregoing it will be clear that the interpoles can affect the speed regulation of a motor. When an interpole motor drops off in speed from no load to full load, it is probable that the interpoles are not sufficiently strong, whereas if the speed increases with increasing load the interpoles are too strong. When properly adjusted an interpole motor will run at nearly the same speed at all loads. For this reason the term "regulating pole" is sometimes used.

In most motors the interpole winding is made with a few excess ampere-turns and correct adjustment is obtained by shunting the winding with german-silver wire or ribbon.

An excellent method of testing the brush setting and interpole strength is by exploring for the neutral. Two pieces of No. 6 insulated wire are soldered to the ends of a piece of lamp cord, the free ends of the wires bared

Fig. 6. Commutator potential "explorer".

for about an inch back and the wires taped together side by side, as illustrated in Fig. 6; the ends of the No. 6 wires should be bent to such a distance apart that they will just span two commutator segments. The free ends of the lamp cord are connected to a low-reading voltmeter. The points are moved around the surface of the commutator, as indicated in Fig. 7, until

Power

Fig. 7. Exploring the commutator.

a position is reached where the voltmeter needle indicates exactly zero, denoting no voltage between bars. The neutral point should be thus determined at no load and the brushes set exactly over this point of the commutator. A load should then be put on the motor and the neutral point again determined. If this neutral point is beyond the no-load neutral in the direction of rotation, the interpole winding is too strong; if behind the no-

load neutral, the winding is too weak. With the interpole strength correctly adjusted the neutral point will be in the same place at no load and full load.

When a variable-speed interpole motor is running with a weakened field it will often be found that the commutating zone is quite narrow; that is, the voltage between bars increases rapidly on each side of the neutral point and a slight brush shift will cause sparking or racing. In such cases it is particularly desirable to have the brushes accurately spaced. The easiest method of locating the brushes is by means of a spacing strip. A strip of heavy wrapping paper about an inch wide is wrapped completely around the commutator under the brushes, allowing the ends to ovelap, as represented in Fig. 8, and a cut is made across the overlapped ends along

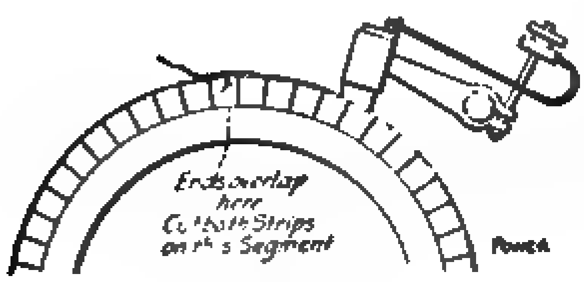

FIG. 8.

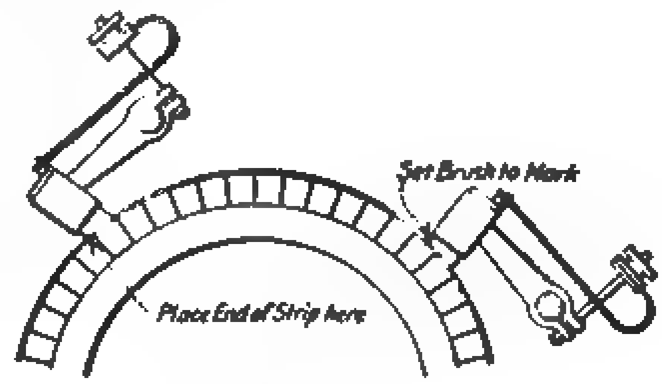

FIG. 9.

a mica segment, so that the length of the paper will be the exact circumference of the commutator. The paper is then removed and its length divided into as many equal sections as there are brush studs, and the divisions marked with a sharp pencil. It is then again laid around the commutator under the brushes, with one end even with the edge of one brush (see Fig. 9); the remaining studs are set so that the edges of the brushes will "toe" the marks. The fiber washers which insulate the studs often shrink somewhat after heating and allow the brush studs to become displaced.

When it is desired to reverse the direction of rotation of an interpole motor, either the shunt field winding or the armature circuit, *including the interpole winding*, may be reversed. Never reverse the armature without also reversing the interpole winding. When either the armature or the interpole winding alone is reversed, the brushes spark and burn under a load and the motor usually gives out a decided hum; also, the speed drops off very decidedly with an increase of load.

FIG. 10. FIG. 11. FIG. 12.

Fig. 11 shows how the shunt field connections of Fig. 10 should be reversed; the leads f_1 and f_2 are merely exchanged where they connect with the external leads F and N. Fig. 12 shows the armature connections of Fig. 10 reversed incorrectly, the armature itself being reversed and the interpole winding left unchanged. The correct way to reverse the armature circuit of Fig. 10 is to transfer the lead N, together with the shunt lead f_2, from the brush cable B to the interpole terminal M and transfer the lead P from the interpole terminal to the brush cable B. This will reverse the current through both the armature and the interpole winding and keep the direction through the shunt field winding unchanged.

—*Power*. December 12, 1911.

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SQUIER SIMULTANEOUS TELEPHONY EXPERIMENTS

Some interesting tests are reported concerning the "wired wireless" system of intercommunication brought out by Major George O. Squier, U. S. A., assistant to the chief signal officer. The first experiments conducted were over a standard telephone cable line of about 800 ohms consisting of twisted pairs in conduit. Success was attained in transmitting two entirely separate telephone conversations over the same pair of wires without the slightest interference being detected.

The system is based upon the application of the principles of wireless-telegraph engineering to wire circuits, the electric waves being guided to their destination with enormously increased efficiency. The problem of interference, which is an inherent defect in pure radiotelegraphy, is practically eliminated as a result of Major Squier's inventions.

On Sunday, Jan. 21, some experiments were carried out with Major Squier's system between the Signal Corps laboratory at the Bureau of Standards and the Baltimore office of the Postal Telegraph Company over a mixed circuit measuring about 660 ohms, which included a small portion of a submarine cable as well as a subterranean line, the main part being pole line of No. 9 copper wire.

The object of this experiment was to determine the order of magnitude of energy required to transmit along wire circuit by electric waves. Both a complete metallic circuit with conductors a foot apart on the poles and a "silent earth" circuit, using one wire with ground return, were employed. The frequencies used were from 3800 to 5000 per second, obtained from a special high-frequency generator in the laboratory at the Bureau of Standards, which is capable of giving frequencies of from 20,000 to 100,000 cycles per second.

The length of the line during the experiment was about 48 miles, which gave 96 miles when metallic circuit was used. The line wires themselves were attuned to resonance for the particular frequency being employed both at the transmitting end and the receiving end. In addition, the receiving circuit was a closed oscillating circuit accurately tuned to the frequency being transmitted on the line. The detector employed was of the well-known vacuum type, the Audion, and the telephones employed were wireless head receivers, 2500 ohms.

It was specially desired to determine the energy required to transmit messages satisfactorily over such a circuit, and it was found that with the

line current at Washington, which was less than two-tenths of an ampere, very satisfactory results were obtained. The voltage employed was so small that it could not be measured with any commercial instrument at hand, so that the actual energy being sent over the line could not be determined. In quantity, however, the energy used in these experiments was far greater than would be required for practical purposes.

—*Electrical World*, February 10. 1911.

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THE TURKISH STRAITS QUESTION

By "P. Wf."

Translated from the German by 2d Lieutenant E. J. W. Ragsdale, Coast Artillery Corps

Turkey's power over the Balkan Peninsula is based primarily on the safety of its capital city from attack. By fortifying the Bosporus and the Dardanelles (both entrances to the Sea of Marmora) and by a comprehensive land defense scheme, the Turkish Government has sought to render Constantinople absolutely impregnable. The task is furthermore facilitated by an international agreement barring all except Turkish war ships from passing through the Straits.

This agreement was the outcome of the Straits Convention in 1841 and was signed by England, Russia, France, Austria, Prussia, and Turkey. It was further ratified at the Paris Convention in 1856. As first drawn up, all war vessels were barred from passage through the Straits, but in the later convention an exception was made in favor of those under the Turkish flag in order to permit that nation to station her ships at the mouth of the Danube. In 1871 Russia obtained the consent of the signatory powers to maintain a fleet of war ships in the Black Sea; this had been prohibited by the Paris Convention. Since then she has found divers ways and means to evade the letter of the convention. In 1891 Russia obtained permission from Turkey to allow vessels of the Volunteer Fleet flying the merchant flag to pass unquestioned. This concession was readily stretched by Russia in 1903 to include four torpedo boats which had come from Cronstat (under the merchant flag to be sure).

During the Russo-Japanese War the terms of the Straits Convention were found to be particularly irksome to Russia. The Black Sea Fleet would have been a great asset to her naval forces in the Far East. Then again after the annihilation of the Baltic fleet this clause became still more objectionable, for the 6 battleships and 8 armored cruisers cooped up in the Black Sea could have been put to good use wherever Russian interests were at stake. Her last attempt to remove the barriers occurred during the Turkish Revolution, but was successfully parried due to British influence. The suggestion from Russia to be awarded this coveted right of passage in compensation for the annexation of Bosnia and Herzegovina by Austria-Hungary was not heeded. Likewise the request of the Czar to the King of Italy to be allowed to return home with his fleet through the Straits. Now the Turko-Italian conflict has offered another pretence to bring the Straits question again into diplomatic consideration. St. Petersburg has long felt that the time is ripe, but so far none of the other powers seem to pay much heed to her suggestions.

Turkey looks upon the control of the Straits as a matter of life and death, and, naturally will not voluntarily agree to any modification of the convention. To throw open these waters to foreign, especially Russian, men-of-war, means to lessen the degree of security at present enjoyed by the capital. That is, unless the coast defenses are kept up to such a state of efficiency that neither passage could be forced. Formerly Russia exerted sufficient influence with the old regime to dissuade Turkey from modernizing or augmenting her coast works, and especially those on the Bosporus. Up to 1908 the guns were mounted on open parapets and armored protection from naval attack was not thought of. But since that period considerable change has been made, a part of the forts have been rebuilt and this time with sufficient protection for guns and gunners.

Should the convention be raised, foreign ships could at any time steam up as far as Constantinople unmolested, and, after the favored amnner of today, strike an irreparable blow. Italy has shown us such examples at Tripoli and Prevessa. The fall of Constantinople means the fall of Turkey.

England's interests in keeping the Straits closed have waned some, now that she is in possession of Egypt and Cyprus. The sea-route to India is safer than it used to be, but still, it is a comfortable feeling to know that the Black Sea fleet is securely bottled up. Then again, England has always assumed the role of "big-brother" toward Turkey and desires to continue in that capacity with the Young Turks. She, therefore, turns a deaf ear toward all overtures regarding a re-opening of the Straits question. The other signatory powers see things from the Turkish point of view, for, should the Straits fall into other than Turkish hands, it would give that nation a decided point of advantage and would be the seed for a big crop of conflicts. Opening up the Straits would be of little consequence, only in case they, as well as Constantinople, were so well fortified as to preclude an attack and, in case the Turkish fleet were reorganized and built up to the point where it would be capable of keeping the Sea of Marmora cleared. But as long as there are no immediate prospects of either, it lies in the interests of European peace to leave matters as they stand.

Since the outbreak of hostilities, Turkey has denied passage through the Straits to all merchant-men which have been engaged in carrying contraband to Italian ports. Originally she detained all grain ships crossing the Aegean Sea, which worked great hardship on the entire British grain industry, as it was a matter of laying off about 300 ships of some 5000 tons capacity each. So, eventually, Turkey held this prohibition to apply only to vessels bound directly to Italian ports, which in itself was a farce pure and simple, as the ships could be dispatched to some intermediate Mediterranean port and thence proceed to Italy without further delay. The Italians have been reticent about establishing a blockade off the Dardanelles, partly out of respect to England's wishes and partly due to the fact that they do not feel themselves strong enough to maintain here, as well as off the coast of Tripoli, an effective blockade.

But in spite of the fact that Italy has so far carefully avoided the Straits, the Dardanelles and the Bosporus have nevertheless such a strategic significance for Turkey that it seems well to look further into the character of their defenses. It is here that the Turkish fleet has found a safe harbor of refuge since the outbreak of hostilities. Incidentally, it may be mentioned that while the fleet was engaged in maneuvers off Beirut, the latter part of Sep-

tember, orders were received to repair immediately to the Dardanelles. Little did one think then of the probability of war, in fact they had but a scanty amount of ammunition on hand. The fleet interrupted coaling and steamed along at about ten knots past Cyprus and the Island of Rhodes. The ships were off Chios before it became known that war had been declared. From here they followed the coast, leaving Chios and Mitylene to the left. All lights were extinguished as it was not known what moment they might encounter the vastly superior Italian fleet. Upon arriving off Tenedos they sighted the enemy's ships in the vicinity of Mitylene. The Turks had escaped complete annihilation by the merest accident. In the meantime their ships had taken on ammunition and supplies at Rhodosto and Haidar Pascha. It is not very likely that they will ever take the offensive toward the Italian fleet, for they are well aware of their own insufficient training and lack of experience with the complicated mechanism of a modern man-of-war. Nevertheless the Turks will keep the entrance to the Dardanelles cleared of Italians.

The Dardanelles is about 40 miles long and 4½ miles wide. On both shores there are chalk cliffs with an almost uniform height of 900 feet. The current flows toward the Eegean Sea, but at no such velocity as would render mining impracticable. At the entrance from the south it is 2½ miles wide and protected by the terraced works of Fort Sedil Bahr on the European side and Kum Kalessi on the Asiatic side, as well as by several shore batteries. These defenses, which have just been modernized, are said to be able to bring 150 guns of intermediate and major calibers into action. Moreover they are unassailable from the rear, but certain of the batteries do lie exposed to higher elevations.

A second group of fortifications is situated some 12 miles further up the strait at the narrowest, and tactically, the most important part.

At this point the breadth is only 1¼ miles. Fort Kalid Bahr is on the European side with Fort Kale-Sultanieh directly opposite. Both are ancient masonry structures which are at present being rebuilt and consequently of no military value. Besides these two, there are also a number of batteries, some on high sites, some low down, and stretched out over a distance of 4½ miles. These latter works are modern and fairly well equipped, supposedly with about 140 medium and heavy guns. The strongest forts are at Sestos and Abydos. They are those of Bogassi Tabia on the European side and Nagara and Medchidieh on the Asiatic shore. Here the mine fields are laid. Due to the narrowness of the channel and the numerous reefs, a fleet would be forced to advance in column. For this very reason the Turks have taken especial pains to amply fortify the position and it is believed that no fleet afloat could force an entrance.

A third defense group lies at Gallipoli guarding the entrance into the Sea of Marmora. In order to protect these works from an attack from the land to the north, (for troops could readily be landed in the Gulf of Seros) a line of fortifications consisting of 2 forts and 10 smaller works with some 60 medium and heavy guns has been established across the narrowest part of the Chersone peninsula at Bulair (Polair). So we see that the Dardanelles, at least, are secure against any such forces as Italy may bring to bear upon them.

The Bosporus is 20 miles* long with a width varying from one to two thousand yards. The banks on both sides are beutifully cultivated and reach a height of about 600 feet, the Asiatic side being somewhat the higher of the two. Since 30 feet of water is found almost up to the very shores, a fleet might advance in line with extended front. Consequently the fortifications have been so located that their guns not only cover the immediate front, but may also be trained up or down the strait.

Here again the defense works are divided into three separate groups. The group furthest north lies at the funnel-shaped entrance from the Black Sea. It consists of the terraced batteries of Rumeli Fener on the European and of Anadoli on the Asiatic side. Still other batteries are located on the adjacent necks of land. South of these by about 2000 yards are situated the castle-like works of Karibdieh Kale on the western shore and Poiras on the eastern. Several defenses of more recent character adjoin them. Numerous formidable batteries, which constitute the second group, are strung along at the point where the Bosporus is only 800 yards wide, about 2½ miles south of Poiras. These may be counted upon to deliver a most powerful fire, either frontal or toward the flanks. The armament of the modern and modernized batteries consists of about 200 pieces of medium and heavy ordnance, some few of which are amply protected by armor. The Bosporus widens out at Boiuk Dere and Jenekoi, a fact that greatly facilitates the matter of keeping the length of the strait in the field of fire. The third group is located south of Jenekoi. It consists chiefly of a number of shore batteries, designed to cover the water area in front of Constantinople and to prevent an enemy's ships from taking up an anchorage in the vicinity.

Heretofore the armament of the Bosporus defenses has been in a wretched condition, but in later years it has shown a marked improvement. The target practice held by the center group with 28 cm. guns in October, 1910, is said to have been very satisfactory. Local conditions necessitate the Bosporus batteries being put in the best possible shape. The strong current flowing southward, together with the prevailing north winds, would greatly facilitate the rapid passage of the Black Sea fleet. The use of mines or torpedos is not practicable. So the defense depends entirely on the fire from the batteries.

The troops assigned to the shore defenses of the Straits are: 2 regiments of artillery for the Bosporus, 1 for the Dardanelles, 1 for Bulair, and an engineer-regiment of 13 companies.

Constantinople is protected from the land side by a line of 3 modern forts and 100 antiquated earth-works, stretching from Baruthane on the Sea of Marmora to Hissar Kajah on the Black Sea. The line is about 6 miles from the city and runs parallel to the Bosporus. These works are practically worthless, but in view of the recent reorganization of the army seem to be superfluous. However, in any case, Constantinople is more than Italy cares to tackle for the present and it will be well for her to bear this fact in mind when peace negotiations are being considered.

—*Deutsches Offizierblatt*, October 19, 1911.

* See map, accompanying article on "The Bosporus Defenses," JOURNAL for May-June, 1911.

Short Notes

German Airships.—It is said that the semi-rigid airships of the *Gross* type are to give place in Germany to the non-rigid, (*Parseval*), and the rigid (*Zeppelin*) types, each being used for a special purpose.

Field Glasses.—Specifications for field glasses for officers of infantry, cavalry, artillery and engineers of the French army are as follows:

Enlargement in diameter, above, or equal to, 6.

Actual field, above. or equal to, 100 mils.

Clearness, diameter of the ocular ring, above, or equal to, 3 mm. (.118 inch).

Cases and straps, black, or brown, except for cavalry which must be brown.

Glasses for infantry officers must have a micrometer, or double-refracting prism, for estimating ranges. Glasses for artillery and engineers must have a micrometer.

Condition of German Coast Fortifications in 1915.—The *Tour du Monde* announces that when the enlargement of the Kiel (the Emperor William) canal, and some other works in process of construction shall be finished, the situatlon of the sea front from Kiel to Borkum will be as follows:

Kiel, a port of refuge and repair, inaccessible to Dreadnoughts, coming from the west; the Emperor William canal which will afford passage for the largest vessels and will connect Kiel with the theater of operations; further west, a chain of fortified places, namely,—Brunsbuttel, Cuxhaven, Wilhelmshaven, Emden and Borkum. Upon that front, Heligoland, an independent fortress, will fill the role of an advanced sentinel.—Translated from *Bulletin de la Presse et de la Bibliographie Militaires*, November 30, 1911.

Krupp Disappearing Gun Carriage.—In the issue of the JOURNAL for November-December, 1911, page 302, appeared a short description of the disappearing carriage for seacoast guns, built by the Krupp firm. The data as to rapidity of fire, which are given near the end of the article, were taken from a pamphlet issued by the firm in 1908.

Later data give the following rates of fire per round for the different calibers:

For	15-cm. gun	10 seconds.
	19 " "	14 "
	21 " "	16 "
	24 " "	20 "
	28 " "	28 "
	30.5 " "	36 "

This is a decrease from the earlier data of 8 seconds for the 24-cm., 6 seconds for the 28-cm. and 4 seconds for the 30.5-cm. guns, a material amount in each case.

The Progress of War Material in 1911.—Trouble in Morocco, war in Tripoli, jealousy between Italy and Austria, and unrest in the Balkans, have

combined to render the past year a busy one for manufacturers of war material. The greater Powers, with the exception of Italy, have already completed their armament of quick-firing field guns, and have of late been turning their attention to field howitzers, mountain guns, and frontier defense guns. All the armies have been increasing their stocks of ammunition.

The Engineer, January 12, 1912.

Small Arms.—The great Powers are delaying the issue of automatic rifles, since in any army were to introduce a new rifle its neighbor would immediately produce another and possibly a better one. The only new automatic rifle issued in 1911 was the Genovesi-Revelli, of which 6000 were manufactured at Terni, Italy, for the Bersaglieri cyclists. The Austrians have a new ranging bullet for infantry, which is exploded on impact by a cap. It is stated that the strikes of a half-section volley are visible at 1200 yards. Experiments are being conducted with rifle grenades weighing about two lbs., fixed to a rod loaded into the muzzle of the rifle, but these have not at present been adopted as a service projectile. Machine guns are still being manufactured in large numbers to complete the armaments of the Principal Powers, the favorite patterns being the Maxim, Hotchkiss, and Schwarzlose. Automatic pistols are replacing revolvers in all the armies except our own. There is a tendency to evade the difficulty of combining an efficient man-stopping bullet with slight recoil by the use of large-caliber aluminum bullet; thus the Schonboe pistol is of .450 caliber and fires a 63-grain aluminum bullet with a velocity of 1470 f.s. The high velocity gives great accuracy at short ranges, while the recoil is very slight.

—*The Engineer*, January 12, 1912.

Fortifications.—Italy and Austria are still busy fortifying their coasts and frontiers against each other. The Italians are constructing powerful defenses on the Adriatic coast, to be armed with 12-inch guns and 12-inch howitzers. Six 40-caliber 12-inch wire-wound guns have been ordered from Armstrongs at Pozzuoli for the defenses of Venice, and the new 15-inch gun is spoken of for the Brindisi forts. On the land frontier, both sides are mounting 6-inch and smaller guns; Skoda has an order for 50 steel cupolas for machine guns and small quick-firers. These are 8 inches thick, cast in one piece, and weighing 13 to 20 tons. The same firm is turning out revolving turrets for 4-inch howitzers firing up to 70 degrees elevation, and for muzzle-pivoted 6-inch guns. Chili is making Iquique into a first-class fortified harbor armed with Krupp guns, and is building defenses at Arica and Tacna.—The Turkish Government, in January, 1911, decided to spend a large sum on coast defenses, including £75,000 for the armament of Tripoli, but nothing was done till too late.—*The Engineer*, January 12, 1912.

Aircraft.—The numerous accidents to the great dirigibles have, to some extent, encouraged the construction of miniature dirigibles, which are cheaper and handier than the unwieldy Zeppelins and Parsevals. Thus the Villehad-Forsmann dirigible is of only 800 meters capacity, weighing under 9 cwt. It is non-rigid, with one ballonet, and has a 24 h. p. engine coupled direct to the propeller. It is stated to have attained a speed of 25 miles an hour, but even this would limit its employment to light breezes. On the other hand, the German Military dirigible "L.Z. 9," launched in October, 1911,

is a large airship with three motors capable of 48 miles an hour. Aeroplanes are now being built with more regard for stability and less for speed. Thus the Lohner-Daimler biplane, adopted by the Austrian army, has the upper plane curved sharply backwards at the ends like the wings of a swallow, while the area of the lower plane is only one-third of that of the upper plane. This construction is said to give great stability in rough weather. With 70 h. p. engine and 9-foot propeller, this plane has a speed of 43 miles an hour. A new projectile for use from aeroplanes and dirigibles is a torpedo-shaped bullet weighing one ounce, intended to be simply dropped on troops below. Owing to its shape this bullet acquires sufficient velocity to kill a man when dropped from a height of 2400 feet. Since a Military dirigible of the "L.Z. 9" type can carry some 16,000 of these bullets as ballast, she would be capable of causing considerable annoyance to the enemy's troops.

—*The Engineer*, January 12, 1912.

Searchlights.—The Russian army has taken the lead in providing means of illumination for troops engaged in night operations. 500 motor projectors are being issued to infantry regiments and staffs, and considerably more will be required before the whole army is equipped.

—*The Engineer*, January 12, 1912.

Saving of Distance by the Panama Canal.—The opening of the Panama Canal will effect the following saving of distances for such ships as may choose the new and shorter route: Europe to San Francisco, 6,200 miles, and to Valparaiso, 2,100 miles; England to New Zealand, 1,600, and to Australia, 800 miles. Between American and Oriental ports the saving will be as follows: New York to Shanghai, 1,400 miles; Montreal to Sydney, Australia, 2,740 miles; and between New York and Australasian ports the saving of distance will average about 2,400 miles.—*Scientific American*, February 17, 1912.

Italian Aviator Shot in War.—Capt. Monte, of the Italian military aviation corps, is the first aviator to be wounded while dropping bombs in actual warfare. On February 1st, while flying with an observer above an Arab encampment in the desert, near Tobruck, in Cyrenaica, and dropping bombs upon it, Capt. Monte was hit by a rifle ball and severely injured. Despite his injuries he managed to fly back to the camp and alight safely, bringing valuable information. The aeroplane was hit no less than four times by bullets. Charles A. Willard, while flying in the middle west, once had a propeller splintered by a bullet from a farmer's rifle, but the case above cited is the first on record where an aviator has himself been hit. Capt. Monte's experience demonstrates that war aeroplanes should have the seat for the pilot and observer protected by light armor and the men themselves should wear bullet-proof clothing such as has recently been brought out in Japan.—*Scientific American*, February 17, 1912.

H. M. S. Lion.—The new British battle-cruiser *Lion* completed her trials on Jan. 17. As she is the first cruiser armed with the new 13.5-inch gun, of which she carries eight, the trials were of an important character. Each of the *Lion's* 13.5-inch, four-inch and other guns was tested with quarter, half and full charge at extreme elevation, extreme depression and horizontally, with satisfactory results, the vessel steaming into the Channel to

avoid fog and traffic. After single tests two 13.5-inch guns in the raised barbette forward were fired together, then one of the two amidship barbettes, and next the after barbette guns, no serious effect resulting from the simultaneous discharge of each pair. No attempt was made to fire the whole broadside of big guns. These trials naturally direct attention to the fact that in offensive and defensive power this year's British ships are in advance of their predecessors. From the 19,200 tons of the *St. Vincent* class development has passed through the 20,200-ton *Neptunes* and the 23,500-ton *Orions* to the 25,000-ton *King George* class; and the extra displacement has been devoted to thicker belts and more powerful armaments. In the same way the armament of the *Indefatigable*, eight 12-inch guns arranged partly in echelon, has given way to the same number of 13.5-inch ranged on the center line. There has been a notable advance also in the character of the secondary armament. The second class cruisers also show evolution along similar lines.—*Army and Navy Journal*, February 17, 1912.

The Latest British Battleship.—The new English battleship, the keel of which has just been laid at Portsmouth dockyard, the first of the five armored ships of the 1911-1912 program, will be known as the "Secret Ship." It is generally known that it is to be the largest battleship built for the British navy, that it is to have an anti-torpedo battery of 6-inch instead of 4-inch guns, as in the older ships, and that there is to be a great improvement in the compartments to prevent sinking in case it is torpedoed. Beyond this the members of the Admiralty are introducing changes which are to remain a secret for the time being at least. Usually the laying of the first keel plate is attended with some ceremony and naval attaches and others are invited. On this occasion, however, only the dockyard officials and a very few others were present. All newspaper men and photographers were rigorously excluded. It is expected that the battleship will be completed in two years.
—*Army and Navy Journal*, February 17, 1912.

New German Oil-Burning Ship.—A marine plant recently completed in one of the principal works in Germany is said to promise great economies in the matter of battleship propulsion. London advices to the New York *Times* have it that this oil-burning plant "is of 18,000 horsepower, consisting of three engines of 6,000 horsepower each; one to each propeller. Each engine has 3 cylinders, producing 2000 h.p. each, the cylinders being double acting, the explosion occurring on both sides of the pistons. The incorporation of such an installation in a war vessel means the abolition of boilers and smokestacks, also the saving of the space occupied by bunkers, as the engines would require less than half a pound per horsepower an hour, which would mean 100 tons of oil per twenty-four hours for full-power, full speed. Any kind of crude or refined petroleum may be used. The original Diesel engine was invented some years ago and the basic patents have expired, but during the past three or four years a great revolution has been in progress in the perfecting of the reliability, performance of duty and economy of the type. The principal problems have been to obtain perfect combustion, to enlarge the cylinder units, and to solve the problem of having the explosion transpire on both sides of the piston." —*Army and Navy Journal*, February 17, 1912.

Wireless Telephony Through the Earth.—It has been announced that an official of the German Post Office Department, Herr Kiebitz, has success-

fully carried on telephonic communication between Berlin and Canada, by means of Hertzian waves through the earth, no aerial being employed. The impulses were transmitted by means of a special generator giving 100,000 cycles per second. The wires connected to the transmitting instrument are carried to two plates imbedded in the earth at a definite distance apart equal to one-half wave-length of the electric waves employed.

—*Electrical Review and Western Electrician*, February, 24, 1912.

High-Speed Steel Welded Armor Plate.—About three years ago W. S. Simpson discovered that plates of high-speed carbon steel, with a thin plate of copper between them, could be welded with a flux consisting of a stiff mixture of carbon (lamp black), brown sugar and water when heated to a temperature of 2000 degrees F. The copper melts and enters into solution with the steel and forms a perfect weld which will not part nor split. The copper appears to increase the tenacity of the steel so that the weld is even stronger than the solid steel. The process is being developed in England for the manufacture of composite armor plates consisting of a tough steel back plate faced with hardened high-speed steel. A plate consisting of 4-inch carbon toughened steel, and 2-inch hardened high-speed steel successfully resisted attack with 6-inch projectiles. A comparison of the process with the Harvey and Krupp processes of face hardening armor plate shows its advantages. The carbonization of a face-hardened plate rarely penetrates more than $\frac{7}{8}$ inch, and while Krupp armor is about 50 per cent. superior to the best Harveyized plate, the Simpson process plate has 75 per cent. the greater resistance.—*Machinery*, September, 1911.

Messrs. Vickers, it is stated, have received an order from the Admiralty to build three improved submarines of the *E* class. They will be longer and of greater girth than any vessel of the submarine class yet built, and will mount two quick-firing guns. These vessels will be driven with a heavy oil engine.—*Page's Weekly*, February 2, 1912.

The Present Status of Wireless Telegraphy.—In a lecture recently delivered at Berlin, Count G. von Arco, after outlining the general working of the main parts of radio-telegraphic installation, began their detailed discussion with the consideration of the antenna problem. Vertical antennas which until quite recently were those most generally in use, are carried by huge masts which must assume enormous dimensions whenever long distances are to be spanned. In fact, the problem of long-range radio-telegraphy has long been dependent almost exclusively on the design of antennas. Whether electric waves are transmitted through the air, the earth or both media simultaneously was until recently an open question, though there was strong evidence in favor of the earth transmission theory. However, the systematic work done by Dr. Kiebitz at the instigation of the German Postal Department has now shown the earth as such to be capable of transmitting electric energy to considerable distances, while sufficient receiving energy, even at the greatest distances, may be derived from the earth alone. The Telefunken Company, on the strength of these experiments, has designed many types of earth antennas exerting well directed effects and apparently preferable in other respects to aerial antannas. The system becomes much more independent of disturbance due to atmospheric discharges and to the inter-

ference of other stations. For the rest the electrical behavior of earth antennas is very similar to that of aerial antennas. As regards, next, the modern system of musical "damped" sparks, this has been further improved upon, and the new apparatus, though of simple design, allows the pitch of the sound to be readily altered. The Nauen Experimental Station (near Berlin), which equaled in power and range the two largest Marconi stations (viz., those connecting England with Canada) has recently been raised to an output four times the initial figure. The height of the tower (originally 330 feet) has been doubled, and two new engines and apparatus halls have been fitted up.—*Scientific American Supplement*, February 10, 1912.

Advance Base Work.—Upon recommendation of the general board and Naval War College the advance-base work of the naval establishment is to be in charge of the Marine Corps. The base on the Atlantic coast has been established at the navy yard, Philadelphia, and this year's naval naval appropriation bill would probably contain an appropriation of $175,000 for construction and barracks and other buildings for the corps at this place. The advance base for the Pacific coast is to be established at the nany yard, Mare Island. The marines already have an advanced base at Olongapo, in the Philippines. As soon as practicable, and when funds are available, advance-base depots will be established in the West Indies, propably at Guantanamo, Cuba, and at Pearl Harbor, Hawaii. It is likely that the House naval committee will recommend an increase of 2,000 men in the enlisted strength of the Navy. If this is done the Marine Corps will probably also be given an increase of 400 men, or 20 per cent. of the naval increase.

—*Army and Navy Register*, February 17, 1912.

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NOTICES

INTERNATIONAL AERONAUTICAL EXHIBITION

Under the auspices of the Aero Club of America, the First Annual International Aeronautical Exhibition will be held in the New Grand Central Palace, New York City, May 9 to 18, 1912. Such exhibitions have been held in European cities, resulting in increased interest in aeronautical matters. A considerable amount of space will be allotted to inventors not yet in position to exhibit complete machines, but who have drawings, or models, of parts to show.

Lectures on aviation, historical, scientific, and educational, will be given by authorities in these various lines, moving pictures of aeroplane flights and exhibits of trophies and prizes shown.

For information, address,

Show Committee,
Aero Club of America,
297 Madison Ave.,
New York, N. Y.

BUREAU OF MINES' PUBLICATIONS FOR FREE DISTRIBUTION

We have been asked to print the following notice:

DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

New Publications. (List 8.—January, 1912.)

Bulletin

Bulletin 15. Investigations of explosives used in coal mines, by Clarence Hall, W. O. Snelling, and S. P. Howell, with an introduction gy C. E. Munroe, and a chapter on the natural gas used at Pittsburgh, by G. A. Burrell. 1911. 197 pp., 7 pls.

Technical Papers

Technical paper 6. The rate of burning of fuse as influenced by temperature and pressure, W. O. Snelling and W. C. Cope. 1911. 28 pp.

Technical paper 7. Investigations of fuse and miners' squibs, by Clarence Hall and S. P. Howell. 1911. 19 pp.

Reprints

Bulletin 31. Incidental problems in gas-producer tests, by R. H. Fernald, C. D. Smith, J. K. Clement, and H. A. Grine. 29 pp. Reprint of United States Geological Survey Bulletin 392. Copies will not be sent to persons who received Bulletin 392.

Bulletin 32. †Commercial deductions from comparisons of gasoline and alcohol tests on internal-combustion engines, by R. M. Strong. 38 pp. Reprint of United States Geological Survey Bulletin 392. Copies will not be sent to persons who received Bulletin 392.

Bulletin 33. Comparative tests of run-of-mine and briquetted coal on the torpedo boat *Biddle*, by W. T. Ray and Henry Kreisinger. 49 pp. Reprint of United States Geological Survey Bulletin 412. Copies will not be sent to persons who received Bulletin 412.

The Bureau of Mines has copies of these publications for free disrtibution, but can not give more than one copy of the same bulletin to one person. Requests for all papers can not be granted without satisfactory reason. In asking for publications please order by number and title. Applications should be addressed to the Director of the Bureau of Mines, Washington, D. C.

BOOK REVIEWS

Electricity in the Service of Artillery of Position. By D. Frederico Revenga y Checa, Chief of Artillery. Malaga, Spain: R. Parraga, 6" x 8½", 251 pp. 76 il. (and wiring diagrams), paper, 1911. Price, $2.32.

This book opens with a brief consideration of the ever increasing use made of electricity in all operations of war, referring especially to the Artillery, shows why electricity is a means of power transmission superior to steam, hydraulic power or air pressure, and then devotes 13 pages to electric lighting, touching upon hand lamps, lighting of platforms, scales and magazines, also the systems of distribution to be used. The artillery officer will find little in this chapter that is new or interesting.

The second chapter refers to motor driven ventilators for emplacements. This would seem to indicate that the Spaniards are ahead of us in this respect, as it appears desirable to reinforce our (sometimes) excellent system of natural ventilation with the "forced draft" principle. Of course this would be more or less of a luxury in time of peace, but under war conditions, with the parados shutting off all breeze from the rear and the men cooped up in the magazines for any length of time, it is doubtful if our system would in all cases supply the requisite cubic yard of fresh air per man per hour. Various types of ventilators are discussed, such as the helico-centrifugal, helico-centripetal, aspirators, inspirators, etc., with a few cuts of same.

Chapter III refers to electric hoisting machinery, including motor driven pulley blocks of various makes. The single and double ammunition hoists, Sautter-Harle type are described in detail, with wiring diagrams. The Breguet and the Couffinhall systems are also well described.

Chapter IV is devoted to the description of "electric control" of heavy guns under two heads, viz., the direct method by means of "controllers" and the distant method by means of relays, both systems considered principally in connection with guns mounted in turrets, or revolving cupolas. The former type is represented by the Canet-Hillarel system and the latter by the Forges & Chantiers and the Sautter-Harle systems all of which are described somewhat in detail, with their wiring diagrams. Nothing is said relative to setting range or elevation by electrical methods.

In Chapter V, relating to searchlights, the general discussion is practically the same as the matter that has been printed in this JOURNAL from time to time. Their general system is broadly the same as ours. The following named systems, involving both manual- and distant-control are described in detail and wiring diagrams given: Sautter-Harle, Siemens-Schuckert, and Breguet. There are also descriptions of the portable outfits of the Barbier-Benard & Turenne and of the Bleriot oxy-acetylene systems.

Chapter VI is devoted to a general study of electrical installations for Artillery purposes. Some of the points discussed are: Selection of location

for power plants; class of current to be adopted, voltage and frequency of same and best system of distribution; calculation of amount of energy needed for various purposes; use of accumulators; then follow discussions of typical installations of A.C. and of D.C. plants, involving for each, the calculations of the mechanical equipment, the electrical equipment, the main system of distribution and its branches, cases for the 3-wire system, most suitable prime movers, etc.

Chapter VII contains some of the most valuable matter in the book. It is devoted to organization of the personnel and to the methods of inspection of military electric plants and all the component parts thereof. It also contains excellent notes on "first aid."

The book as a whole would, if translated, make interesting reading for the Coast Artilleryman, but the great number of technical words that cannot be found in any available dictionary renders the book rather difficult to the average officer. Some of the matter is decidedly worth while, but most of the rest is more or less obvious. The press work is fair but the binding is of such character that it disintegrates almost immediately. This fact alone would seem enough to render the price of the work to high.

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Untersuchungen ueber die Bewegung der Langgeschosse, (Discussion of the Motion of the Elongated Projectile.) By N. Sabudski. Translated from Russian into German by Lieutenant Rittu von Eberhard, I.G.A., Retired. Berlin: Fr. Grubb. 154 pp. 17 il. 6½" x 9½". Paper. 1909.

This work is a very able, mathematical discussion of this intricate subject. The author introduces his subject with the statement that in examining the results of high-angle fire, it is found that, if the initial velocity is not too low, the actual range is greater than the result obtained by computation using the assumption that the axis of the projectile coincides with the tangent to the trajectory during its entire flight. Moreover, the greater the initial velocity, the more marked is the difference. He explains this phenomenon by saying that there must be an effective force tending to raise the projectile.

In the third chapter he shows how in the motion of the ogival projectile a component of the air resistance may arise whose direction is vertically upward, due to the difference of the direction of the axis of the projectile and the tangent to the trajectory, and that in some cases there may exist even a component imparting a velocity of translation.

The author shows that the total difference between the actual and computed range is not accounted for by the effect of these forces alone. He assumes still another component of the air resistance which increases the range in proportion to the rotary velocity of the projectile about its axis. His conclusions are based on the results of trial firings with 9-inch and 11-inch mortars. He says that the existence of such a component of air resistance can be explained on the supposition that during the passage of the projectile through the air, various currents arise as soon as the angle between the axis of the projectile and the tangent to the trajectory exceeds a certain magnitude, due to the combined effect of the forward and rotary motions of the projectile—which air currents meet at the lower side of the projectile and exert a pressure upwards, thus tending to lift the projectile. The author

devotes the four chapters and appendix comprising his work to theoretical investigations relative to the motion of the axis of the projectile, for the purpose of explaining the above questions, as well as some other phenomena observed at firings.

The introduction is devoted to the grouping of the results of firings, and stating the conclusions which may be drawn from these trials and theoretical investigations. In the first chapter the differential equations of the rotary motion of the ogival projectile are deduced from Euler's differential equations of the motion of a rotary body, on the assumption that the angle between the axis of the projectile and the axis of impulse is small, and that all powers of this angle save the first may be disregarded in the development. He shows that for the trajectory of the projectile to be uniform, the above conditions must be fulfilled, and hence the derived equations are sufficiently accurate to solve ballistic problems. From these equations new differential equations are derived which permit the determination of the position of the axis of the projectile relative to the tangent to the trajectory on the assumption that the angle between the axis of the projectile and the axis of impulse can be disregarded. This chapter ends with expressions for determining this angle.

The method of integrating the differential equations of motion which determine the position of the axis of the projectile relative to the tangent to the trajectory is shown in Chapter II. There, too, he shows the method by which can be calculated approximately the values of the angles which determine these positions in all cases, that may arise in firings, by assuming that the moment of air resistance is proportional to the air resistance and an expression $\sin\delta$ or $\sin\delta\cos\delta$, by simply changing the proportional factor for different values of the angle δ.

Chapter III is devoted to deducing differential equations for the motion of translation of the ogival projectile, and also to finding formulas for the corrections which must be applied to the ranges that were obtained on the assumed coincidence of the axis of the projectile with the tangent to the trajectory throughout its entire extent. By means of these derived formulas, it is possible to calculate approximately the magnitude of the range corrections, when the angles which determine the position of the axis of the projectile relative to the tangent to the trajectory are known.

In Chapter IV concrete examples of high-angle fire of 11-inch mortar and flat trajectory of 3-inch gun are given, where the derived formulas are applied. The appendix is reserved for the discussion of fundamental equations of motion in general as well as some of their properties. After this the fundamental equations of motion of the ogival projectile are deduced on the assumption that the center of gravity of the projectile remains fixed. From these equations the author deduces the differential equations of the rotary motion of the projectile, on the hypothesis that the angle between the axis of the piece and the axis of impulse is small and that its higher powers may be disregarded. These equations are deduced by introducing the air resistance as the cause of the disturbance.

With both of these two methods as well as that mentioned in Chapter I, the author obtains four differential equations of rotary motion identical in form with that which was published for the first time in 1880 in his dissertation entitled "Fundamental and Differential Equations of the Motion of the Projectile when the Air Resistance is Introduced as a Disturbing Function."

War or Peace. By Brigadier General Hiram M. Chittenden, United States Army, Retired. Chicago: A. C. McClurg and Co. 5¾" x 8½". 273 pp. Cloth. 1911. Price, $1.00 net.

This book is a plea for foreign nations to disarm and submit their differences to arbitration.

The author's views in regard to America's duty may be gathered from the following extracts:

> "Disarmament by this government in advance of other great powers would be an unwise—a perilous—policy. The true line of duty is to maintain and even increase our military and naval strength, and this on the grounds (1) of prudent provision against possible danger, and (2) of strengthening the position of the Untied States as a power for peace. * * * The external policy of the United States government, we may feel assured, will never be one of aggression, but of fairness, justice, and equal favor to all nations. Reasonable security and a respectable standing with other nations in those outward symbols which denote national power are the limit of our military ambitions. In the face of such a policy it is difficult for any other nation to find a substantial cause of war with us, for at this period of the world's history, a civilized power feels that it must justify itself in the good opinion of the world before it deliberately goes to war. It is noteworthy that no foreign power has ever attacked us first. * * * In the present situation it would be impossible to reinforce one coast from the other after the outbreak of war in time to anticipate a hostile attack. The mere statement of distances shows this. San Francisco is 13,107 miles from New York *via* the Horn. Yokohama is 4,521 miles from San Francisco, or one-third of this distance, and Hamburg is 3,577 miles from New York, or one-fourth of this distance. Reinforcement in face of a preponderance of distances of 8,600 miles in one case and 9,500 in the other, with no port of call except on neutral territory, would manifestly be impossible. Under present conditions, therefore, our safety demands a fleet on each coast superior to that of our assumed antagonist on that coast."

In other words the author believes in a two-power standard, under present conditions with regard to the Panama Canal. We heartily approve his desire for a strong navy. Granting, however, that our naval bases in the Pacific are defensible in the absence of the fleet, we can by no means agree with him that a two-power standard is necessary for our fleet; we are surprised that he has accepted the divided fleet fallacy; we believe that plenty of foreign shipping will be ready and willing to supply coal and other contraband articles to enable our fleet to get around the Horn: and we believe that as long as we have a superior undivided fleet, it will matter little whether this fleet be in the Atlantic or in the Pacific at the outbreak of war. Continuing, the author says:—

> "With the Panama Canal completed, the distance from New York to San Francisco, adding say 600 miles for the delay in passing through the canal, will be about 5,900 miles, which is nearly 1,400 miles greater than the distance from Yokohama to San Francisco and nearly 2,300 miles treager than from Hamburg to New York,

> If the passage through the canal should be without accident or unusual delay, Japan would still have practically three days and Germany five days advantage in time compared with that of a fleet sailing from one coast to reinforce the other after the outbreak of war. How far this advantage could be offset by anticipating war and moving our fleets into closer proximity to each other, and still not precipitate hostilities, is wholly a matter of conjecture. But even with the most favorable assumption, our safety in war with either of these nations singly, after the canal is available, demands that we maintain a fleet on each coast equal in fighting efficiency to at least three-fourths that of our assumed antagonist. It ought then to be possible, without completely denuding either coast, to reinforce the other in time to defend against attack, or to prepare for an offensive movement."

Assuming that the navies of our possible antagonists are of equal strength, it will be observed that the author is in favor of a one and one-half power standard.

In speaking of the Panama Canal he says:—

> "We chose to open this great commercial highway and at the same time make it a part of our system of national defense. In this latter respect it is a duty to make ourselves secure in advantages for which we have given so lavishly of our treasure. No possible guarantee of neutrality can be accepted, as a substitute so long as the liability of war remains. To hold the canal free for passage by a nation with which we might be at war would be to sacrifice one of our chief weapons of defense. No rational consideration could justify such a course, and any other nation in a similar case would instantly repudiate it. * * * Considering the vast sacrifices made in building this mighty work, it would be a dereliction of duty not to secure in the most absolute sense the results of such prodigious efforts. When universal peace is assured among nations, then and not till then, will our government be justified in withdrawing armed protection."

In speaking of disarmament he says:—

> "Right or wrong, the great measure of a nation's standing among other nations is the outward expression of power in the form of military preparation. We should not voluntarily surrender, but rather strengthen, our influence in this respect. A great nation, we should not deliberately make ourselves a little nation."

These views in regard to our military policy are illuminated when considered in connection with the author's utterances with reference to the European situation. In discussing armed peace he says:—

> "Referring again to the Anglo-German situation, a candid analysis discloses so many inconsistencies and contradictions as to make it seem impossible that the common sense of these two peoples can much longer stand the strain. The two-power policy of Great Britain is of comparatively recent date. A much smaller preponderance was formerly considered sufficient. Manifestly any given standard must be purely artificial and, if applicable at one time, is

almost certain to be inapplicable at another. The very effort at fixity of standard is itself an absurdity. When other great powers, like Germany and the United States, take up navy building in vigorous earnest, it becomes impossible for England to keep ahead of both combined, except at ruinous cost to herself. At present it would seem that efforts are directed to maintaining twice the naval strength of Germany. This gives Germany a tactical advantage over her antagonist, for by laying down a given number of battleships, she can compel England to lay down twice as many, and may thus eventually wear her out financially. And the shameless feature of this rivalry is that neither nation is gaining any relative advantage in naval strength. All this vast increase in expenditure is absolutely unnecessary and is forced upon these two nations only through their fear and distrust of each other. It is difficult to paint this picture in all of its enormity."

Separated as we are from possible powerful enemies by great oceans it ill becomes us to lecture the English upon the measures they deem necessary for the protection not only of their Empire and commercial prosperity but their lives and property and the freedom which they have guarded nearly a thousand years. It may be added that the Prime Minister of England has publicly stated that the American navy is not considered in computing the strength required to maintain the two-power standard.

England owes her immunity from conscription and invasion to the protection afforded by the Channel. Even this protection the author is willing to impair. He says:—

> "Suppose that the project of building a tunnel under the English Channel from England to France were revived. What would constitute legitimate objections to the project and what would not? If physical difficulties should appear to be practically insuperable, or if the cost promised to be so great as to make the project financially impracticable, either of these obstacles would be valid and conclusive. But the if project were feasible in these respects but were to be deferred because England felt an 'instinctive revolt' against permitting any land connection between her soil and the continent, such an objection would not be valid in the same sense that the others would be. It would be purely factitious in character, an outgrowth of past political conditions, largely a creature of imaginary fears, and in no sense of sufficient weight to entitle it to stand for a single day. And yet this invalid objection, so long as it should be entertained, would be just as effective in preventing the execution of the project as insuperable physical or financial obstacles would be."

This is merely a question of principle. if one tunnel is good, a score would be better and it would have been still better had nature made Britain coterminous with the Continent from Dover to Land's End; but then the British would now have conscription and an immense standing army, which the author justly deprecates.

By advocating a two-power standard for America the author confounds the effect of the great [illegible] of the western hemisphere [illegible]

> "Canada, with only one-fourteenth the numerical strength of the United States, has no more to fear invasion by her powerful sister than has Ohio of invasion from Pennsylvania. But if these two countries were to assume the attitude toward each other of France and Germany, if the public thought were to be stirred up by the talk of invasion, if military clubs in both countries were to commence discussing problems of offense and defense, all this sense of peaceful security would vanish and there would be the same feeling of suspicion and unrest which to-day creates such a dangerous tension between England and Germany."

Here the author mistakes effects for causes. We might as well draw conclusions about the possibility of world peace from the long-standing peace between Spain and Andorra. Hegel pointed out more than seventy years ago that the United States does not maintain standing armies against Canada and Mexico, because they are not "objects of fear." But let us suppose that each of these nations were approximately equal to the United States in population, wealth, and naval power; that the populations of the three countries were overflowing; and that they were all seeking new lands in other continents for their people to colonize. Does any one doubt for a moment that these three countries would assume the attitude towards each other of France, Germany, and Great Britain; that the public thought would be stirred up by the talk of invasion; that the military clubs would discuss problems of offense and defense; that the sense of public security would vanish; and that there would be the same feeling of suspicion and unrest which creates such a dangerous tension between England and Germany?

The author is a sanguine advocate of universal federation, of a world-parliament, a government which will be entirely self-sustained. Such a union he believes would be easier of accomplishment than German unification,

> "because a world-union would not be of such intricate character nor require so large a surrender of individual authority as was the case in either the American, or German, unions."

If it be urged that such a government would lack the physical force to carry its decrees into effect, the author believes

> "that physical force will not be required for that purpose. Its sanction will always be a moral sanction. Who to-day believes that the army of the United States, or the army of Germany, in necessary to enforce the central authority as against the component parts of either of these countries? Nothing could be more repugnant to the enlightened sense of either of these nations than such a suggestion."

History will not bear out this contention.

It is worthy of note that all schemes for world federation contemplate that the world government shall issue its mandates to the subordinate governments, after the manner of the Continental Congress under the Articles of Confederation and of the German Confederation of 1815. From its jurisdiction, the author would exclude all questions of territorial integrity, the Monroe Doctrine, civil wars, immigration questions, etc.; in other words all vital interests, the real causes of war, which almost invariably are not mentioned in declarations of war.

We believe the author is guilty of many fallacies. When he speaks of American affairs he shows the effect of a sobering sense of responsibility; when he speaks of a foreign nation his imagination runs riot and he advises courses which he would be the first to condemn if he were a citizen of the country concerned.

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Probability of Fire. (Probabilite du Tir.) By Captain S. Burileano, Roumainian Army, Professor in the Artillery and Engineer School of Application, Bucarest, and Professor of Mathematics in the University of Paris. Paris: O. Doin and Son, 8 Place de l'Odeon. pp. 258 + xii. 5" x 7¼". 60 il. 5 francs.

This work is divided into three parts. Parts I and II deal with the general theory of the calculus of probabilities. Part III deals with applications to small arms and cannon.

The volume is valuable to officers on account of its completeness and of its direct application to practical military affairs.

The importance of this subject is not always recognized, but a working knowledge of the principles involved is essential to economical and effective use of either infantry or artillery. Anyone interested will find this a most excellent work.

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HANDBUCH DER WAFFENLEHRE. (Ordnance Manual). For officers of all Arms for self-instruction, especially in preparation for the War Academy. By Berlin, Major and Inspector of Foot Artillery material, Member of the Artillery Proving Commission. 3rd edition rearranged and enlarged. Berlin: Ernst Siegfried Mittler and Son, 68-71 Koch Street. 317 pp. 18 pl. 6" x 8¾". 1912. Price, unbound, 11 m., bound, 12.50 m.

In this volume, modern ordnance and gunnery, especially with reference to field artillery and small arms, is treated with the comprehensive thoroughness and minuteness usually attributed to German writers. The consideration of propelling and bursting charges occupies the first pages of the book and is followed by an excellent study of the trajectory and the various causes affecting the flight of a projectile.

The infantry weapon of the German army is fully described and the small arms of the other great European powers are then carefully studied. Similar treatment is accorded machine guns, light and heavy field artillery, and to a limited extent coast artillery. Some space, devoted to guns for repelling and attacking dirigibles and aeroplanes, shows that this treatment of the subject of ordnance is thoroughly modern. Fire control for field artillery, communications, types of projectiles and grenades complete the manual which thus covers fully the science it aims to describe.

Of interest to coast artillerymen is the comparatively small space devoted to the description of German coast guns and mortars. It is interesting to learn that "the newer coast guns are frequently mounted on disappearing carriages," a photograph and description of which was published in a recent number of the JOURNAL. The mortar carriage is somewhat similar to our own, Model 1906, the mortar recoiling in a cradle. It permits traversing through 360°, and the projectile weighing approximately 700 lbs. attains a

maximum range of 13,000 yards. The rate of fire is from two to three shots per minute.

The manual is of particular value to anyone desiring full information concerning the equipment of the great European nations, both as regards field and coast artillery, although the latter is merely outlined. A list of the various types of guns, mortars, and howitzers employed by each country, together with much data about them, is an important feature of the book, which is well arranged and possesses a good index so that desired information may readily be obtained. The excellent diagrams and illustrations which abound add a great deal to an appreciation of the text.

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Artillery in Battle. (**L'Artillerie dans la Bataille**.) By Colonel J. Paloque, Commandant of the 18th Regiment of Artillery and formerly Professor in the Superior School of War. Paris: O. Doin and Son, 8 Place de l'Odeon. pp. 449 + XII. 5″ x 7¼″. 14 il. 5 francs.

This volume of the Encyclopedie Scientifique, is clearly the work of an author thoroughly conversant with his subject. It is admirably arranged and very complete. Taken in conjunction with the other volume of this encyclopedia by the same author, "Artillerie de Campagne," it affords a compact library on the use of field artillery and is worthy of translation into any language.

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Interior Ballistics. By Colonel James M. Ingalls, United States Army, retired, formerly Instructor in Ballistics at the U. S. Artillery School. New York: John Wiley and Sons. London: Chapman and Hall, Limited. IX + 221 pp. 6″ x 9″. 4 il. 2 pl. 1912. Price, $3.00 net.

This is the third edition of the author's work on Interior Ballistics, and will be welcomed by those familiar with his other works on ballistics and with their influence on the development of the science of gunnery in the United States.

The book is characterized by excellent and logical arrangement and by its completeness. It includes numerous tables of ballistic functions, and about one third of the entire text is devoted to applications of the method to service and other guns, to various forms and sizes of grains.

The publishers have done their work well and the volume is well printed and attractive.

The back is worthy of minute inspection and criticism. It is divided into six chapters, of which the first is devoted to definitions and fundamental conceptions and includes an historical sketch of early experiments with gun-powder. Chapter II deals with the properties of perfect gases and the action of gun powder in closed vessels. Chapter III deals with the combustion of powder grains of various forms under constant pressure and gives further definitions.

In chapter IV the author deals with the motion of a projectile in the bore of a gun. As it is here that several fundamental assumptions are made on points with regard to which authorities are not always in accord, it is desirable to enumerate them. The author assumes

1. That the velocity of combustion of all powders is proportional to the square root of the pressure.

2. That the co-volume is the reciprocal of the density of the powder.

3. That the powder burns in parallel layers.

4. That a fixed number of expansions corresponds to the maximum pressure, the number being 0.45 for degressive and 0.80 for progressive forms of grain.

In chapter V numerous applications are made to guns of various calibers and with powders of many forms and sizes of grain.

In Chapter VI the effect of rifling is discussed and illustrated.

The text is completed by the addition of the necessary tables.

The following points are noted after a careful survey of the text:

On page 11, the author describes cordite as consisting of 65 per cent. of gun cotton, 30 per cent. of nitroglycerine and 5 per cent. of mineral jelly or vaseline. He then states "This is also very nearly the composition of the powder used in the United States army and navy." It should be stated here that the powder used in the United States army and navy is pure soluble nitrocellulose, the solvent being an ether-alcohol mixture, and the stabilizer diphenylamine.

With reference to the assumptions made in Chapter IV, the following comment appears necessary:

1. The pressure exponent as assigned by nearly all authorities is actually ½ for black powder and for brown powder. For smokeless powders it seems to lie between 0.6 and unity and probably varies with the pressure.

2. For black and brown powders the co-volume averages 0.6 and the density 1.67. Consequently, the co-volume is actually the reciprocal of the density. For nitrocellulose powders the co-volume is very nearly unity and the density about 1.58. For cordite the co-volume is 0.80 and the density is about 1.6. It is seen, then, that for smokeless powders the co-volume is not the reciprocal of the density. The effect of this assumption in the case of smokeless powders is modified by the fact that the term which vanishes on account of this assumption is proportional to the amount of powder burned and is inversely proportional to the travel, and by the fact that when one of these is large the other is small. It would seem that a mean value might profitably have been used. The effect of this assumption is especially pronounced in the case of short guns, such as mortars and howitzers, and increases with the charge.

3. For modern powders the powder probably does burn in parallel layers, as indicated by experiment, but for black and brown powders, this is an assumption of doubtful accuracy. It is, however, the most probable simple hypothesis.

4. The travel to maximum pressures is taken nearly twice as great for progressive as for degressive powders. It would seem that the *degree* of progressiveness should enter, and a separate value of the number of expansions should pertain to each form of grain.

The author states that "a moderate variation of the position of maximum pressure will have no practical effect upon its computed value." This is due to the fact that a function at or near its maximum changes its value slowly. But, while this is true, it is also true that a change in the position of the maximum pressure distorts the curve for a given work area and gives different chase pressures from those pertaining to the true position. This matter is of importance in gun design.

On page 96, it is to be noted that the force of the powder as given by the solution of the inverse problem varies with a power of the charge. For the 14-inch gun it is found (p. 161) to vary with the first power of the charge. Undoubtedly the waste work, (such as friction on the walls of the gun, forcing the band, etc.,) absorbs some of the energy, but for service charges hardly enough to cause the force to be proportional to the charge.

The conditions which actually obtain in the bore are, however, so little understood, even now, that no one may with certainty rely on pyrostatic experiments. Pyro-dynamics is still a matter of theory with ill-defined premises, and the ultimate test is "agreement with facts." The methods given in this book have already endured that test in numerous instances and at the hands of practical men, among whom may be mentioned Captain Hardcastle, R. A., who states with reference to the employment of the formulas with cordite "After many dozens of calculations, I can find no serious disagreement between the results of calculation and experiment."

The gratifying success of Colonel Ingall's latest work will give great pleasure to the many whom directly, or indirectly, he has led towards the light.

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Medical Service in Campaign. A handbook for Medical Officers in the Field. Second Edition. Prepared under the direction of the Surgeon-General, United States Army, and published by authority of the War Department. By Major Paul F. Straub, Medical Corps (General Staff), U. S. Army. Philadelphia: P. Blakiston's Son & Co., 1012 Walnut Street. 5″ x 7½″. 13 il. 2 plates. 186 pp. 1912. Price, $1.50.

The second edition of this work brings the subject-matter up to date and in conformity with recent editions of the Manual for the Medical Department and of Field Service Regulations, and with existing orders and regulations. Additional matter appears in several chapters, which further elucidates the subjects. All plates are new and are much improved. This admirable book continues to be the standard American work on the principles of sanitary tactics.

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Le Vol Sans Battement. (Flight Without Flapping.) A posthumous work by L. P. Mouillard, revised with a preface on "The Unknown Work of L. P. Mouillard" by Andre Henry-Couanmer, Mining Engineer. Paris: Libraire Aeronautique, 40 Rue de Seine. 9″ x 5¾″. 480 pp. 12 il. 3 plates. Paper. 1912. Price, $2.00.

The preface of this unusual work is of special interest as indicating not only the versatility of the mind of M. Mouillard, but also his almost limitless capacity for research. Among the numerous essays, brochures, etc., discovered among his effects were found results of investigations upon the following widely diversified subjects, viz.: The Phosphorescence of Marine Animals, The Science of Agriculture, The Naile (river), Political Science, Sugar, Natural History, Chemistry, Egyptology, etc., etc. He was also an artist of no mean pretensions, his works being executed in both oil and water, to which is to be added his prolific contributions to the science of aeronautics.

Dying practically penniless and friendless, and at that time almost unknown, it was by the merest chance that the true value of his researches became known to the world.

M. Mouillard died at Cairo on September 7, 1897.

As early as 1866 he compiled the results of his observations on bird flight in an ""Essay on Orinthology Applied to Aviation." It is impracticable to even enumerate the various contributions to aerial flight that rapidly followed this essay. The value of these researches is summed up in the following statement by the editor of the present work:

"As the result of his laborious observations upon the methods (of flight) of birds in their efforts to utilize and overcome the currents of the aerial ocean, Mouillard discovered the basic principles upon which all future dirigibles airship must be constructed. * * * * * His contributions to the science of aeronautics will be utilized twenty years hence, but their authorship will not be attributed to him."

Part One of *Le Vol sans Battement* (Flight without Flapping) is devoted to the description of the methods of flight of various birds, embracing all sizes, shapes and weights, and to a close analysis of these methods. The use (by birds) of the head in varying the center of gravity in relation to the center of figure, the relation of the area of the supporting surface (wings) to the mass supported, of the breadth to the length of wings and the consequent effect upon the velocity of flight, the use of the tail as a vertical rudder and especially as a warping plane and many similar details are discussed at length.

It was while studying the flight of the vulture—"the grand glider"—that Mouillard discovered the all important part played by warping planes as used in the aeroplane of today.

In a letter to M. Octave Chanute (the American Engineer) dated November 20, 1890, he explained "the mystery of the warping of the wings—the means used by birds in free flight."

This principle was mentioned in *L'Empire de l'Air*, an earlier work by the same author, but it was not until it was emphasized in the present work that its vast importance was recognized by those most interested in the science of aeronautics.

In an interview with M. Frank St. Lahm (published in *L'Aerophile*, July, 1910) the Wright Brothers acknowledge their indebtedness to M. Mouillard as follows:

"We were about to abandon our efforts when the work of M. Mouillard fell into our hands and we have (since then) continued our investigations with the results before you."

Part Two is devoted to the discussion of "Aerial Apparatus" and embraces almost every stage of development since 1678. The use of captive balloons in order to investigate the meteorological conditions of the higher air strata and aerial currents, of parachutes as a means of safety in the event of accident, of kites for various and sundry purposes are fully discussed.

He classifies the modern heavier than air aeroplane into two classes, viz., stationary or fixed, and motor propelled. On account of the state of development of electric motors at that time (10 years ago) his experiments with motor propelled airships were uniformly unsuccessful. In spite of these numerous failures, his faith in ultimate success remained unshaken and on page 285 we find this declaration:

"Find a motor capable of developing a velocity of 25 meters per second in a mass of from 80 to 100 kilogrammes, and the problem will be solved."

Part Three contains general discussions and axioms, many of which, although mentioned in *L'Empire de l'Air* (1881), have been amplified and emphasized in *Le Vol sans Battement.*

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Photograph by Boston Photo News Company.

UNITED STATES BATTLESHIP FLORIDA (1910)

Normal displacement, 21,825 tons; full load, 23,003 tons; complement, 888; length (waterline) 510 feet; beam, 88¼ feet; maximum draft, 28½ feet. Armament: 10, 12-inch, 45 caliber; 16, 5-inch, 50 caliber; 2 submerged torpedo tubes. Armor (Krupp): 11-inch belt; 10-inches upper belt, amidships; turrets, 12-8 inches (N.C.). Parsons turbines; 4 screws; 14 Babcock boilers; designed h.p., 28,000. Maximum speed, 22 07 knots.

(See pages 340 and 341.)

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"La guerre est un métier pour les ignorans et une Science pour les habiles gens."

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Second Prize, Essay Competition of 1911

HOW MAY THE BEST RESULTS AT COAST ARTILLERY TARGET PRACTICE BE SECURED, —INCLUDING PRELIMINARY INSTRUCTION, TRAINING, PREPARATION FOR, AND CONDUCT OF, PRACTICE,—FOR GUNS OF 8-INCH TO 12-INCH CALIBER

BY FIRST LIEUT. GEORGE A. WILDRICK, COAST ARTILLERY CORPS

Target practice may be divided into three stages. In their order they are:—

1. Preparation,
2. The practice,
3. Analysis.

Each stage being intimately related to the others in a properly conducted practice, it is of the greatest importance that the battery commander should exercise a close and careful supervision over each step, to the end that the operation of the personnel and materiel, and deductions therefrom, may be properly coordinated. No greater fallacy can receive credence than that a practice having been once fired is completely ended. It is in so far as the figure of merit is concerned; but if the end is there we have stagnation. Whether the figure of merit is high or low, the lessons can be equally valuable if the battery commander has the details of preparation and execution well digested, and has accurate records from which to draw con-

clusions and lessons for the future. Analysis discovers errors, new conceptions, more practical knowledge of artillery, improvements for the future. When we have these we have progress.

It should be the aim of every officer to be better than any of his men at any position in the battery. They should learn the difficulties of each position and therefore be enabled to prescribe the best methods. Nothing should be taken for granted, nor any detail left unperfected. Often the simplest modification of a method will result in a remarkable advance in accuracy and speed. But to know how to perfect the performance of a duty the officer must know exactly the end to be attained and the difficulties to be surmounted. We have excellent material in the ranks. Our men do a lot of good, and often creative, thinking about their work. To destroy their confidence by defective instruction is fatal. For uniform success, leadership born of confidence is necessary—driving, alone, will not suffice. An officer must be capable of teaching every detail, and the results will measure his ability.

The firing of a gun is no more nor less than an experiment in physics. With accurate laying, uniform weights of blended powder, proper ramming, and proper adjustment of the carriage, the gun will generally shoot where it ought to,—not necessarily where it is expected to on defective data. Too many errors are often charged up against a gun or lot of powder. The writer has served for two seasons with a battery at which calibration firing had previously been held. The firing was considered a failure due to defective powder. At approximately 6000 yards the dispersion was excessive. At ranges averaging close to 8000 yards, the writer has been with the battery for three practices in which were used one of the lots found defective during calibration. Of the sixteen record shots fired, tan were hits on the material target; and of the six misses, four can be accounted for as having been fired on erroneous data. In the analysis of the records certain errors were identified, and these errors numerically accounted for the excessiveness of the range deviations of these four shots from the expected center of impact, and all of them should have otherwise been hits. In each case the errors were discovered from the records and traced definitely to their source. In other words, fourteen out of the sixteen should have been hits, for all the hits were justified by the records. And narrow banded projectiles were used. It was a melancholy realiza-

tion that four of the misses were due to several unique conditions that had not been anticipated in the instruction, yet the analysis has fortified officers and men against a repetition of these errors, because their existence, importance, and likelihood of reappearance are now recognized.

It is convenient in this discussion to begin with the training and work of the personnel in the observing stations, then to trace the information through the plotting room to its final application on the guns. Having finished with the fire control, to consider the service of the piece and of ammunition, the keeping and analysis of records, and concluding with the duties of the officers at the practice.

In so much as satisfactory results require that data correctly determined must be accurately delivered throughout the system, we are confronted at the very outset by the problem of securing efficient use of the telephone. Here especially will methodical instruction bear fruit. It is needless, and perhaps harmful, to go into details in describing the construction and circuits, for a temptation is thus created for the operator to attempt repairs which he has no business to make. Sufficient are the simpler tests of the transmitter and receiver, switching to the available source of power, and examining the exterior contacts for loose connections. We have splendid telephones, and serious troubles are infrequent where there is no abuse.

Although the natural tone of an operator is ill suited to efficient transmission, experiment will generally develop an affected tone which will produce excellent results when, on account of especial skill, it is desired to utilize a man at a position where a telephone must be used. Practice in enunciation will produce clear-cut words, while syllables must not be run together, but each one must be distinctly uttered. In fact, enunciation is a matter of just handling the syllables properly. Messages uttered with a nasal tone at a moderate pitch of the voice are usually received very clearly. With a moderate amount of painstaking instruction as a foundation, almost any man can become an efficient operator after he becomes accustomed to the phone. A few men cannot learn how to transmit the vernacular messages, especially if they have a marked foreign accent; and a few can not receive. Receiving cannot be taught methodically like the technique of transmission, but is dependent upon a man's hearing and familiarity both with the phone and the words used. It is

here that patience on the part of the instructor is most necessary; for nervousness may be frequently the novice's stumbling block, and any sharp criticisms may only aggravate his difficulty. For it will be often noted that a man ordinarily inefficient at drill with the telephone can carry on a conversation to town over the long distance with great facility. The secret of his ability in the latter case is that he is mentally at ease and the words used in the conversation are familiar to him. Once he gets used to the messages employed in drill, the meanings of the terms, and the pronunciation of the words, his efficiency is established. To this end two telephones can be profitably installed in the barracks during the indoor season and the instruction hours devoted in part to the training of classes of gunners in using the telephone. Then the drill at the guns will not be hampered at the very outset by any inefficiency of the personnel in this respect.

In the first place the observer should have a detailed knowledge of the theory of operation and the construction of the instrument which he operates; this in order that he may care for it intelligently and operate it with a full appreciation of the errors to be expected and avoided in any system of tracking employed at the battery. For each type of instrument an ordnance pamphlet is furnished which fully covers the construction and operation, so it is therefore impracticable and needless to consider all the types here. But there are a few fundamentals to be observed with all of them.

Fatigue breeds inaccuracy as well with the eye as any other organ of the body; therefore the observer should be required to focus the eyepiece carefully for the eye he is to use every time he operates the instrument. This is done, of course, by elevating the telescope until a portion of the vertical hair is seen against the open sky and so adjusting the eyepiece that every roughness on the edge of the hair stands out in the sharpest relief. He should be trained, moreover, to use either eye, making the change when desired and a lull in his duty permits him to set the eyepiece properly for the other eye in case his eyes are not uniform. It should be explained that this change and adjustment is for the resting and protection of his eyes and that continued failure to comply with the rule will result in fatiguing and straining the eye, impaired vision, and ultimate disqualification for the position. The next step is eliminating the parallax by properly focussing the objective. To check this adjustment for any range, move the head later-

ally or vertically across the eyepiece, while maintaining the sight through the telescope. If there is no apparent movement of the wire across the image, the objective is properly focussed. This method is excellent on a fixed object, but somewhat more difficult and more necessary where the target is moving either in azimuth or range. During tracking on a moving target it may best be done by placing the horizontal hair on some well defined point or line of the target, if it is moving laterally, and by moving the head up and down test the adjustment of the horizontal hair. If the target is coming head on, or nearly so, with small lateral travel, test similarly with the vertical hair. If either hair appears fixed, the parallax has been eliminated. When the observer is proficient in the method of adjusting the range and aximuth mechanisms according to the pamphlet, the next step is checking his ability to aim accurately. It is not sufficient that he aim with a constant error, for the ranges will be correspondingly erroneous for any system of tracking employed at the battery. This can be done by selecting small well defined aiming points and directing him to train the intersection of the hairs thereon. The instructor verifies each setting and gradually requires more and more rapid alignments on various other objects. He is next required to track on a moving target, after having been cautioned to aim on a certain well defined point, and to have the vertical hair accurately aligned and to stop traversing sharply on the third stroke of the bell. The instructor then reads, records, and differences the travel in azimuth during the intervals and discusses the results with the observer. After his accuracy in observing on objects of known range has been demonstrated, the candidate is similarly trained in tracking vertical base. It is explained to him that for horizontal base the vertical is the critical wire, and that for vertical base the horizontal wire must receive the most attention. His ability in tracking by the latter system is checked by ordering both systems at the same time and comparing the results. That is, B′ furnishes both range and azimuth, the latter only being applied on the plotting board with the azimuth from B″.

The reader must be alert and methodical. Excessive speed should never be required, for it is never necessary and only causes inaccuracy. He should keep his mind centered upon his duty and start reading the instant the instrument halts on the third bell. His attention is then fastened first on the whole degrees exclusively. When that number has been

transmitted with the "point," his attention is directed to the hundredths, which are then sent. He is therefore reading only one number at a time, besides giving the armsetter a chance to get the whole degree set before the decimal comes rushing along. After a little practice the men get teamed up, and it will only take three or four seconds to set the arm. Moreover the operation is accomplished systematically and almost, it might be said, automatically; for the less a man has to remember, the closer will his performance resemble the regularity of a machine.

Although the azimuth and length of the base line have been determined with the greatest care, and although the observing instruments readily give precise information, the operation of the plotting board must be approached with the realization that only most careful work and precautions can prevent losing much of the accuracy which is vital to a successful practice. Long use produces looseness in the bearings and backlash in the gears, while the smallness of the scale makes rapid accurate readings of ranges difficult and springing of the arms under pressure may easily create excessive errors. For these reasons each man at the board must be trained to a precise, uniform performance of every detail of his duty until the method becomes a habit.

The armsetters should first be taught how to use their hands. Many men are slow because at the beginning of their work at the position they started faultily and have never thought to seek a better method. One hand is sufficient to move the arm, the fingers operating the locking lever and the thumb locking and unlocking the plate. The other hand is then constantly free to set off the decimal part of the degree. Each hand is thus trained to perform one act, while the armsetter concentrates his mind on the correct receipt of the message as a whole, first setting the degree and then the hundredths as each part of the reading is received. He repeats back and calls "set." He should see that the index on the plate is properly fixed, and not turned from its proper position; that the box is locked tight for each setting; and that he has the time-azimuth-travel relation constantly in mind as a check on the reader, as an assistance in setting the arm by anticipation, or to supply a setting in case a reading is lost. As a method of instruction in the last particular the range officer may cut off communication between the reader and armsetter during drill and leave the switch open for an interval

or two to see if the latter has the relation in mind and to prepare him for the contingency of a lost reading. If the range has been sent to the guns, he may unlock the arm when necessary on the first stroke of the bell and be setting the next degree by anticipation by the time the reading starts to come.

In addition to keeping the plotting board in the best practicable adjustment, the plotter must secure perfect quiet in the room, permitting only the short prescribed phrases necessarily employed, and these in no louder tones than expedient. Such phrases as "Talk louder, will you? I can't hear!", are quite unnecessary. Instead, "Repeat," or "Repeat louder," are quicker, more orderly, and produce better results. Nothing more surely destroys the rythm of a plotting detail's performance than superfluous conversation or the advice of self-constituted critics. In sliding the targ to the intersection, great care must be exercised not to bring too great a pressure against the secondary arm; especially is this important with the older type of narrow arms which have too little rigidity. Such pressure produces on the small scale of the board erroneous range readings, fictitious angular travel, and fictitious range travel, which latter applied on the range board has caused many a miss, although the angular error may appear in only the first shot. Another thing to be considered is the play, if there is any, in the bearings where the arms are pivoted, or where the coupler is attached. In reading ranges the gun arm should always be brought up to the targ from the same direction. At best the accuracy of the tally dial is questionable, due to the smallness of the pinion, the consequent backlash, and its light construction. By moving the gun arm to the targ uniformly from the same direction much of the lost motion is eliminated and more accurate angular travel readings are consequent. Remembering that at 8333 yards actual range the allowable error on each side of the center of the target is only six one-hundredths on the sight, the necessity for this precaution is obvious. But in computing the deflection there should be no instrumental error at all, thereby having six one-hundredths leeway for wind conditions not discernable ashore.

It is unfortunate that the gun arm is so stenciled that the plotter must read the figures upside down, but this defect gives rise rather to inconvenience than to error. In reading the ranges the eye should be directly above the critical edge of the

targ so as to avoid any parallax, while the reading should be made with such dispatch only as is consistent with deliberation and accuracy. It appears very nice in drill to get the ranges off to the guns within six or seven seconds after the bell, but since the data is not correct until the end of that interval it would appear that there is no cause for haste, and speed should be subordinate to unerring accuracy. By way of a suggestion, the gun arm might be furnished with a slide for reading ranges similar to that on a mortar arm for determining elevations. A triangular lip projecting downward would replace the targ; and if the lip was beveled forward to a point, the plotted position of the target could be readily and precisely penciled.

The assistant plotter must keep a sharp watch on the movements of the gun arm, setting the azimuth travel dial and reading it only when the arm is in the proper position. In addition he should keep the wind component indicator correctly set at all times for reference. And because the range correction scale is so convenient, he may record the correction used and glance at the index from time to time to see if the gun arm has slipped.

An instrument or mechanism furnished the battery for fire control purposes can be considered as a synopsis of the elements of the theory of gunnery pertaining to that function for which the instrument or mechanism is supplied. The parts are so proportioned and mounted that by accurate operation the proper value is obtained for application in firing. Obviously every officer should know not only its operation, but also the theory of it, the function of each part, and whether the information on which it is originally set is correct. It is quite as fatal to allow a wrong azimuth or velocity value of the wind to be used as it is to read a range incorrectly. A miss is a miss, whatever the cause, and our progress depends upon our ability to identify the sources of error and practice preventive measures.

The operation of the range board deserves the closest attention, both from number 4 and the range officer; by the former that the computation shall be made with the greatest refinement, by the latter that the proper values are given to the several quantities added. It is fruitless to drill a section up to a high standard of facility and precision only to fire trial shots with a 40 wind when it should have been 30, throwing the deviation of the center of impact into the powder, then fire the

record with a 30 wind which may be properly 40, and wonder why the shots went over. Such a contingency is more to be expected now than in previous seasons when the trial shots were followed by the record string on the same day and generally under the same general conditions. Many of our meteorological stations are wretchedly placed. Nearby buildings, hills, or trees cause results materially at variance with the real velocity and direction of the wind on the sea. If we are to depend upon a rigid system of fire control we must have meteorological data of scientific accuracy determined for the conditions which the projectile will encounter in its trajectory. As a matter of interest the writer took an anemometer out on the tug one day during a target practice; and while anchored to observe the trial shots anemometer readings were taken at frequent intervals. The wind averaged between twenty and twenty-four miles per hour on the pilot house, while at the meteorological station ashore it was eight miles. At another practice the wind was about fourteen ashore and twenty-four at the tug. At another practice the azimuth of the wind read accurately at the meteorological station was almost exactly 180 degrees from the direction it was blowing upon the ocean, the error being caused by a local eddy. Similarly the thermometer and barometer used in determining the atmosphere reference number should be carefully operated and properly located. The elimination of these and similar errors constitutes a local problem which should be solved by every officer of a battery depending for data upon a particular meteorological station. The effects of an erroneous "daily message" are fully as fatal and far more insidious than an error in range reading; for the latter may be recognized and corrected, while the former may be the principal contributory cause of a poor practice without ever being discovered. Before firing a trial shot or a record series, estimate the velocity and azimuth of the wind and roughly check the values given in the "daily message." Skill in making such estimations can be attained by noting during drill the effect of the wind upon sail boats, etc., and comparing with readings taken on an anchored boat. An error in the "daily message" during the trial shots will cause the determination of an erroneous powder velocity, and the error will continue to appear in the corrected range of every record shot fired, whether the meteorological data furnished for the series is correct or not. This of course must be avoided, for it is a fight for inches to keep in the danger space.

Another important point to be considered is the travel correction, for it includes both the expected travel during the interval and during the time of flight. In addition to eliminating lateral play in the ruler and making it parallel to the range lines on the board, it is necessary to adjust the travel range scale so that its upper edge will be likewise parallel to the range lines and also at the proper distance from the line of zero range,—this latter that the proportionate allowance for travel during the time of flight may be correctly determined. An error in finding the travel during an observing interval is doubled in the range correction when the time of flight is fifteen seconds. An error in setting the arms, or a springing of them may readily produce a fictitious travel of ten yards less than that which would be correct; this error produces an error in the range correction of $10 + \frac{12}{15} \times 10$ yards less than the true correction when the time of flight is twelve seconds,— a dangerous error when we consider the smallness of the danger space at long range. Then if the arms are properly set on the next bell, inversely erroneously on the second, the error becomes ten yards more than the true travel and the corresponding range correction will be too great by $10 + \frac{12}{15} \times 10$ yards. For this reason alone a dispersion of thirty-six yards may be expected if the shot is fired on each of the resulting corrected ranges; the measure being made of course on each side of the expected center of impact. It is possible that some of the so-called "straddling of the target" has been due at times to this cause. Obviously it would be good practice to fix upon some method by which this source of error may be eliminated. One way is to add four or five successive travels together, find the mean, and apply the mean as a travel reading in determining the range correction. To accomplish this, two methods suggest themselves: The first is the use of a supplementary chart, the second is the use of the range board itself.

The chart may be conveniently made of cross-section paper mounted on a board; a string with one end pivoted at the intersection of two heavy lines, the vertical one of which is the normal, and the other end fastened to the index of the travel bar on the travel scale; this last is so mounted that its reading edge is four inches from the pivot of the string, at right angles to the normal line, and with its origin on the normal. The

travel scale is graduated to 100 yards to the inch, to conform to the scale of the chart, but it is otherwise similar to that on the range board. Four successive travels are added together by setting them off continuously, while the average is determined in accordance with the principle of proportional triangles by reading the distance from the normal to the string along the horizontal line one inch from the pivot. This average is then used on the range board.

The same result may be obtained on the range board itself by drawing a horizontal line on the right side of the board and at the range whose time of flight is $3\frac{3}{4}$ seconds. Starting with the index of the travel bar at the normal of the travel scale, it is moved continuously in the direction, and to the amount, of the travel for four successive intervals. Since the travel scale is graduated for a fifteen-second interval, we may get one quarter of the sum of these four travels by reading from the normal to the string, along the line drawn for the purpose at $3\frac{3}{4}$ seconds. The index is again set at normal and this average value is applied as is any travel usually read. After the travel has been thus worked out and applied just preparatory to firing a record series, it is generally safe not to correct any more; for during the short time consumed in firing, the target cannot vary its course materially. On the other hand, it has been discovered that too much correcting for the travel has caused errors in the range corrections computed during firing. Especially should number 4 be cautioned against using the travel of the target during a given interval if, during that interval, he has applied a new range correction on the gun arm,—for by the very application of the correction he has created a fictitious travel during that interval.

By thus taking the means of series, more stability is gained, while there is no necessity for making very frequent alterations to satisfy battle conditions where the weight of a war ship would prevent sudden changes of range travel of any appreciable magnitude. Especially is the necessity for this precaution emphasized where the target is moving on a course parallel, or nearly so, to the front of the battery and is near the shortest range of the course. Here the actual range travel is almost zero, but an error of reading or armsetting will cause erratic corrections for travel.

In computing the deflection, the determination of the true angular movement of the target presents the great problem. Due to the back lash between the rack on the gun arm and the

pinion actuating the pointer on the azimuth travel device on the plotting board, erroneous values may be readily secured. The back lash will be partially avoided if the plotter handles the gun arm carefully and brings it up to the targ from the same direction for each reading of the range. Also, as in the case of the travel used on the range board, the errors may be averaged out. But the gun pointer's test as prescribed in the drill regulations gives an excellent check on a gun pointer's ability to get the travel of the target during the time of flight. Having trained these men, it is conducive to accuracy to have each gun pointer determine the travel, then compare their results, and either have the travel as thus determined combined at the guns with the deflection for the drift and wind, or transmit the travel to the plotting room to be converted into a reference number and applied on the deflection board. This travel is of course compared with that secured from the azimuth travel device. Any appreciable discrepancy is promptly reported to the battery commander. From the observation of the splash of the first shot, the gun pointers should be capable of making any additional corrections from observation of the splash.

The range and deflection having left the plotting room, they pass through the hands of the final man of the fire control section,—the range keeper. If properly trained this man may exercise a very favorable influence over the accuracy of the battery. In his operàtion of the time range board he can readily recognize an erratic range transmitted from the plotting room, or he may supply a predicted range in case a range is erroneous or lost, thereby preserving, in the latter exigency, the continuity of the gun section's service of the piece. His instruction should not be limited to merely the mechanical operàtion of the time-range board, but should include a thorough grounding in the fundamentals of tracking, and particularly in the reasons for which an allowance is made in the range correction for travel. It should be impressed upon him that a range received from the plotting room is not correct, and should not be applied on the gun, until the third stroke of the bell at the end of the interval during which the range is received:—that is, that from a given position of the target as determined at the beginning of an interval, a range correction is computed which includes both the expected travel of the target during that interval and during the time of flight if the piece is fired at the end of that interval. Therefore a range

should be plugged in as received, but the slide should be so moved that it will take fifteen seconds for the index on the slide to pass from the preceding plug and arrive at this newly placed plug at the end of the interval. By watching the index, the range setter can know at every instant just what the range setting should be. It is the practice in some batteries to rely on the plotter for correct estimations of the range, when an error is apparent, from his memory of the ranges or the plotted course of the target. At best then reliance is placed upon his judgment alone in preference to the instruments provided, even where part of the track is covered by the arms and estimation is very difficult. On the other hand, the range setter has the successive ranges before his eyes, as recorded by the plugs, and can eliminate instrumentally any eccentricity.

Another value of the time-range board is its use in quickly applying an arbitrary range correction from observation of fire. Instead of sending the correction to the plotting room to be applied there,— a method adapted rather to taking advantage of the camera records of the first record series for the second firing than to the exigency of an action where rapidity and flexibility are so essential,—the correction may be called to the range keeper. Say it is plus 100 yards: The range keeper uses the tenth mark on the slide to the left of the index, as a new index, and so moves the slide that this new index occupies the position which the index itself would normally have. The index then indicates to the range setter ranges which are 100 yards greater than are being received. The smooth operation of the plotting room is not disturbed, and the method would be particularly applicable in action in case the plotting room was destroyed. Nor will the results be materially at variance from those obtained by throwing the correction into the powder; for at the longer ranges the velocity curves are approximately parallel, while greater errors are allowable closer in because of the increase of the danger space and in the ease of making corrections arbitrarily from observation of fire.

It may be believed that permitting a range keeper to supply ranges by the time-range relation when a range is lost or, as received, is apparently erratic, is allowing him too great a latitude and responsibility. But that is what the board is for, and if he is properly trained both in subcaliber practice and during drill by having the plotter purposely create either of these conditions, there is no reason why the method is not entirely feasible and accurate. The only conditions where it

fails is where either the target suddenly varies its travel or a new range correction is applied on the gun arm. In the first case the range keeper will see his error after two or three readings, and it will be the exceptional case where a battleship will make many sudden changes of course. To meet the second condition, notification can be sent when a new range correction is applied on the gun arm. But the general condition is satisfied. It is one of the cases where the general plan is valuable, in spite of a possible minor defect, so that the emergencies of an action may be met without a cessation of accurate fire.

Having placed the duty on the range keeper of furnishing the range at each moment, all the range setter has to do is to keep the piece laid at the elevation shown, but corrected for the gun displacement. And since that condition is most important in which a hostile target is coming in, the successive ranges should be set by moving the gun in depression for the final setting for each shot. This promotes uniformity in the action of the carriage by taking out any lost motion against the preponderance of the gun. The final elevation having been given after the gun has risen in battery, the range setter calls "Range set!" to the gun commander. A refinement may be introduced by making an allowance for four or five seconds of range travel in the final setting.

The training of a gun pointer is one of the most interesting, as well as important, features of preparation for action,—the ultimate object of all target practice. When everything else has been shot away and only the emplacement itself remains, the gun pointer still is there to turn careful training into fighting efficiency. The range keeper still keeps up the original time-range relation, modifies it, or throws in arbitrary corrections under the directions from the sighting platform. The gun pointer observes the fall of the shots and is the last individual in a position to exercise emergency control. Our allowance of service practice ammunition and the regulations governing target practice preclude such control, but he should nevertheless make an estimation for each shot for comparison with the records, and in emergency subcaliber practice and drill he should be trained at times to exercise such control in order that the system may be developed as supplemental to control by the battery commander. The best system is that which provides for any emergency and in necessity will proceed without a command.

Under normal conditions, however, his principal duty is to give the gun the proper aim, and the development of this ability is the primary object of the battery commander's attention. The principles governing the training of a marksman, as given in the Provisional Small Arms Firing Manual, 1909, can be followed in this case. Make the man proficient first in the theory, construction and use of the sight; second, teach him how to aim; third, teach him how to make corrections; fourth, develop the most rapid and accurate method of getting on the target; fifth, impress upon him the method of recognizing and preventing any errors due to faulty action in the carriage or sight itself.

The particular model of sight used at the battery is described by an ordnance pamphlet; therefore the first step will be omitted here.

As in the case of the observer, the gun pointer must be required to focus the eyepiece and objective very carefully. The sight being adjusted, he is taught to aim at various fixed objects and his aim is checked by skilled persons until he overcomes any individual errors. For a moving target the instructor has the gun tripped and places a model 1898 sight in the bracket on the right gun trunnion. The sights are checked with each other on some fixed object at or beyond mid-range and any necessary allowance is noted. Then the candidate is told to get aimed on a particular point of the moving target and to give the command "Fire" when accurately pointed. The instructor at the sight on the trunnion hears the command and can verify the aiming on the instant the command is given. Errors are pointed out, and the practice continues with the same deflections being used on both sights. Proficiency having been attained in this step, the splash is announced at various points on the target and the candidate is instructed in correcting his deflection from observation of fire. Following this comes training in taking the travel, the gun pointer's test, and in getting on the target rapidly. For the last is required close cooperation on the part of the traversing detail, which may be developed by the following drill: When on proper point of the target, the gun pointer gives the command "Fire", simulating the firing of a shot. At this command a noncommissioned officer starts a stop watch and calls "In battery,—trip," at the end of the loading interval. At the command "In battery," the traversing detail starts traversing the piece under the direction of the gun pointer. At the end of the tripping interval,

the word "Ready" is given, and time is measured from then until the gun pointer gives the command "Fire", while at the same time the instructor is at the sight on the trunnion and checks the aim. Any time over four seconds between "Ready" and "Fire" is considered unsatisfactory. The type of traversing mechanism may require that the gun be halted when the sight is aimed on or near the bow of the target, in which case the command "Fire" is given as the center of the target comes up on the vertical hair. If this condition exists, and the traversing is stopped so early that the center of the target passes the hair before the command "Ready", the trial is considered very poor. This method develops a high degree of cooperation between the gun pointer and the traversing detail, while the work of each individual is checked throughout.

In subcaliber practice the use of two sights is especially valuable in that the instructor can judge of the accuracy of both the aim and the correction from the observation of fire, and when an error is made he knows the cause, whether due to the faulty aim or to the ill-timed firing of the piece by number 3. By purposely giving erroneous deflections, the gun pointer will receive the maximum amount of training in making corrections, and if the loading and tripping intervals are strictly observed the highest efficiency must result.

After the drills have been repeated for morning after morning, an excellent rate of execution is easily maintained and becomes well within the ordinary capabilities of the men concerned. Then, before target practice, impress it upon them that accuracy is the prime object. Let them know that slight delays can be pardoned, but misses never. The first shot is the only one that should be pardoned if inaccurate, and an error in the first deflection should not necessarily be blamed upon the gun pointer. But this man must be accurately on the center of the target, for the other gun pointer must assume that condition in making his correction. Unless this is so, this other man's correction will be erroneous, although the gun pointer firing may know the error and may make a proper allowance in his correction.

While the carriage may be properly cleaned throughout and adjusted, the action of the counter-recoil system may vary as the result of the firing, and the carriage may bump more or less severely upon arriving in battery. In many sights this causes a movement of the hair from its setting. This movement may be also produced by firing. The gun pointer must

therefore be trained to see that the deflection is properly set both after the gun arrives in battery and after the shot is fired;—the former to insure accurate aiming, the latter to permit an accurate correction. In making both these checks the interior horn scale in the older models of sights was a big advantage. To verify the setting after the gun arrives in battery, it is not necessary to interrupt the aiming; and in correcting from observation, the target can be waterlined by the horn scale in aiming and an error read on the scale as on a ruler even if the the vertical hair is not on the center of the target the instant the shot strikes.

Since the service of the piece is fully covered by the drill regulations, and since each caliber of the primary armament has its own drill, it is superfluous to attempt anything like a detailed description of the duties of each man. It seems more desirable to discuss only the general fundamental methods of securing accuracy and speed. Speed and accuracy are accomplished by performing the proper act at the right moment in a clever and uniform manner. Thus, when each man has been well grounded in his duties and the time for their performance, he is taught the technique of each movement. To start with, he is taught the foot-work,—how to get to a position quickly and how to retire, without confusion to himself or anyone else. Often a powerful man cannot be placed at a position where his strength is needed because he is clumsy, for no attempt has been made to teach him in detail how to be graceful. A little instruction will often correct his faults and make him one of the must efficient men in the section. He just did not know the steps. Footwork is fully as important in the service of the piece as it is in boxing or football. Next show him how to use his hands and the best grips; when, where and how to grasp and when to let go.

Ramming is surely as important as any other act required of a gun section. It should be impressed upon each man that every time they ram a projectile faultily they cause a miss. They will respond to the significance of that statement more than to any dissertation on the density of loading or the escape of gas. Under the guidance of the truck detail the truck is run up to the breech and is locked as it brings up against the breechplate. The momentum thus provided is increased by pressure from the rammer until the projectile rings as it is seated in the bore. Number one's primary duty is to steady the rammer head against the projectile, but the other men on

the rammer must endeavor to drive the projectile right through the bore. Each man should grasp the staff with both hands at his particular place, the Vs formed by the thumbs and forefingers pointing to the rear, the body in advance and leaning forward. The men should keep their balance until the projectile has left the tray, when their bodies are thrown well forward in running until their balance is only regained with the seating of the projectile. Short rapid steps are the best, as they permit the best control over one's balance. All look to the front and keep the staff in line with the axis of the bore, so that the head of the rammer cannot slip from the base of the projectile and every ounce of pressure will be utilized.

When the projectile is on the forward end of the tray, it will be noticed that there is a slight sag. To protect the rotating band, allowance for this sag should be made when adjusting a truck for loading so that the front of the tray is slightly above the lowest element of the powder chamber. Then as the projectile enters the chamber there will be no danger of bruising the rim of the rotating band against the rear edge of the gas check seat. Such a deformity may permit the escape of an unusual amount of gas past the projectile.

Time may be saved by training the breech detail to start opening the breech before the gun comes all the way down to the loading position. This instruction may well be given by having the gun retracted to the highest position at which the block can be properly operated. The breech detail thus gain experience in this phase of their duty and are prepared to perform it efficiently under conditions of actual firing.

In inserting the powder sections, the man handling them must be cautioned to see that they are properly laid on the tray and that there is no danger of binding and tearing as they enter the chamber; also that the rear section is only so far inserted that the mushroom head will press against it slightly when the breechblock is fully closed. The great defect in the drill with dummy sections lies, of course, in their difference in form and rigidity from service charges. And since loading with the latter is the more difficult, the greater is the necessity for correcting every error developed during drill in the handling of a dummy.

As a time saver in the case of a defect like a broken sight during practice, ammunition should be ordered transferred at times during drills in order to accustom the men to this variation if an emergency requires the order. Still another is to

determine by trial the best locations for the trucks preparatory to firing and to require that they be placed there before each drill.

The instruction of the powder detail should not be limited to a few directions just preparatory to firing. Their instruction is also conducive to speed and accuracy. To promote the former end, have the dummy powder sections in the magazine or at the place approved by the fire commander. In the drill it is assumed that the gun is fired at the command of the gun pointer, whereupon the powder is brought up and the piece is loaded as in action. Their influence as regards accuracy lies in their handling the powder just previous to and during firing. When it is evident that the field of fire will be clear, and permission to commence has been given, the battery commander orders the powder to be opened at the proper place. All charges are inspected, and if any are torn the fact is immediately reported. The sections are laid out on a clean table and are freed of any fragments of paraffin that may be sticking to the bags. In case "Cease firing" is given and a long delay seems imminent, the charges should be replaced in the storage cases in order to prevent any appreciable variation in the temperature.

Not the least important member of the section is number 3. In a great number of times in which lanyard troubles have developed during firing the fundamental cause has been that this man has not had proper instruction. It has been assumed that merely pulling a rope requires no especial skill. In his case quite the contrary is true. Methodical training of this man is one of the very best preventives of missfires, broken lanyards, and misses for deflection. After he has been taught how to coil and uncoil the lanyard, to remove the old primer and insert the new one, utilize every tripping of the gun (as in "exercising" the carriage) for instructing him in keeping the lanyard free of the breech mechanism, what place to occupy with reference to the gun so that there will be a straight pull to the rear on the button wire, when to take in the slack, the best method of holding the lanyard and making the pull, and how to fire the gun promptly at the command of the gun pointer. As the piece rises in battery the lanyard is payed out, only a moderate tension being maintained. Number three moves out to his position. As the safety lanyard is released, the slack is taken up and he assumes the position for firing. A very good position is that in which he stands facing to the right, feet well

apart and knees bent, the lanyard passing around the front of his body and held taught against the right hip, the left arm extended toward the breech, and the left hand grasping the cord. At the command "Fire", the left knee is straightened and the right is bent enough more to throw the body to the rear a sufficient distance to sharply pull the button wire through the distance for which it is designed to move, without exerting an unnecessarily heavy strain on the lanyard when the button wire has been drawn back to its limit. Ample power is thus applied, but the body is always under control, and the pull is sharp, short and powerful. When thus trained, a man will not feel duty bound in the excitement of firing to yank the lanyard apart merely to fire the primer.

To train number 3 up to close cooperation with the gun pointer, give him the full advantage of subcaliber practice by requiring him to use the long lanyard instead of a short one. He then becomes thoroughly habituated to the use of this lanyard, to all the minor difficulties that may appear, and to firing the gun from the loading platform sharply at the command. One of the numbers on the subcaliber platform can perform his duties at the breech for him:—he gets enough of that practice during ordinary drill.

The adjustment of the carriage as prescribed by orders and regulations is so fully covered by those publications that only a few points will be observed here. Where lubricant is required, see that there is enough of it and that it is clean and fresh. No matter how inconvenient it may be to get at, inspect every bearing surface, for those which are the hardest to get at are the ones which will most probably be shirked. If there is a friction device, see that it is dry and properly adjusted; if there is a spring, see that it is elastic; make sure each nut is tight; have the crosshead guides cleanly lubricated, particularly the lower part where the friction during the beginning of recoil is the greatest; if the range scale is in degrees—not yards, as is the case on some of the older carriages—cut a circular zinc strip, screw it on, and make your own range scale with a clinometer; test the setting of the elevation index by the clinometer, moving the gun in depression; carefully bore sight; have the recoil cylinders clean; in fact, methodically test and adjust every instrument or mechanism pertaining to fire control or to the guns, carriages and accessories as required by orders, regulations, or common sense.

Blending powder is held by some to be an excessive refinement and not a service condition. Discourage that idea as well as any other which creates indifference to the proper execution of any preparation for target practice which has been amply justified by experience. We are not doomed to be attacked on an instant's notice; and if the battery is kept up in the way it should be, there will be plenty of time for the last few preparations as in service practice. Blending, moreover, favors uniformity in the action of the propelling power, without which consistent results are impossible and all the painstaking training of the personnel may be thrown away in so far, at least, as the figure of merit is concerned. A thorough blend gives the maximum chance of uniformity in quality; it follows then that, in making up the charges, equal weights of nitrocellulose powder be put in the several bags. A convenient way of attaining this end by method (a), C. A. M. No. 11, 1910, is as follows:—Weigh each section as it is removed from the case, tag the bag with a number, and record the weight in the second column of the record sheet on the same line with its number. Record the weight of the empty sack in the third column. The difference, entered in the fourth column, is the weight of the nitrocellulose powder, eliminating both the bag and primer charge. After all the sections have been thus weighed, total the fourth column, divide by the number of sections, add this mean weight to that of each bag and primer, and record the result in the fifth column, which gives the proper weight of each bag when filled.

Make every effort to get the best scales on the post, and use every care to preserve their adjustment. Place and remove each section carefully and allow no rough handling on the platform. It is possible to weigh to the ounce, the advantage of doing which is obvious when one studies the effect of variations of weights of powder at the longer ranges. Then remembering that the variations between sections may be cumulative as a source of range errors, due to using two or more sections to the charge, make every effort to get the weights equal to the grain.

It is remarkable how much rough usage the powder in the primer charge will stand. Men will raise and drop the full bag on the floor in order to pack it; which process will be found to be safer, quicker, and easier if the lacing is left intact and the bag is opened at one end, cutting along the seam; then as the blended powder is poured in, tamp moderately with a wooden

handle like that of a broom. No difficulty will be experienced in restoring the required weight. After the bag is sewed up, roll it on the floor and take in the slack of the lacing. A firm, rigid section results. If any bags are torn or appear weak, mark the cases in which they are placed so that they can be identified and used for trial shots, where the loading is more deliberately done. The damper the magazine, the more necessary it is that the resealing be done so thoroughly that there will be no danger of moisture penetrating the powder. And in the later handling of the powder before firing, every precaution should be taken to secure the cases from hard treatment which might cause breaking of the sealing and consequent damage to the charge. To the same end make a careful inspection of the paraffin on the remaining full cases after the trial shots and the first record series, making such repairs to the sealing as the concussion may have made necessary.

There is a refinement even in preparing projectiles which, while not of itself a service condition, tends to create such a condition. That is giving the ogive a coat or two of asphaltum varnish in order to produce uniform surfaces against the friction of the air. Although the entire surface of our battle ammunition is machined, the ogives of our target practice projectiles are unfinished; and it stands to reason that if the latter are left without smooth ogives, variations in range between shots must be expected on account of the unequal resistances they will experience from the air. In the absence of definite tests, the real value of this preparation is of course problematical; but the labor involved is comparatively negligible, and the performance is one of the many opportunities where one may figuratively present the goddess of chance with a bunch of violets in order to win a smile. Nor is it bad practice, along the same line of reason, to remove all the paint from the body as well as the bourrelet, since all the friction developed is not confined to the ogive.

One of the greatest stimulants to interest in drill is the knowledge on the part of each man that his work is to be checked and his ability weighed. Healthy rivalry is excited, competition is raised, an opportunity is afforded each man to make an important place on the team, and efficiency becomes a live issue. This is the function of analysis.

After the regular men and substitutes have been trained in the normal performance of their duties, one or more model courses are prepared and the several computations involved

are carefully worked out and codified. Then the sheets bearing the azimuths from the observing stations are furnished the readers and the assumed meteorological data is posted. Data for a five or six minute's drill is sufficient, the rest of the hour being devoted to checking and discussion, or to an additional course. Where two or more courses are prepared, the several sheets pertaining to each should be properly lettered or numbered so as to be readily identified and to avoid confusion. Practice is had as in regular tracking, the readers transmitting the azimuths on the successive bells and records being kept by numbers 1 and 2 of the reading set. Other members of the section record the values applied on the various instruments and the results obtained. In the discussion which follows, all figures are compared with the original; errors are pointed out, investigated, and preventive measures explained. It is made clear that the work done is being compared with perfection, so that success may be a source of elation and minor errors no cause for discouragement. In an analysis the most difficult point to check is the accuracy of the elevation of the gun when fired. Insomuch as the corrected range embraces the travel of the target, the time relation must be considered, and allowance made. The ranges should therefore be transmitted to the range keepers and range setters, applied on the guns, and a signal sent to the plotting room at each command "Fire". A clerk in the plotting room records each range and deflection sent by the plotter and notes by the T. I. clock the number of seconds the gun is fired after the bell on which a given range was correct. Not only is the work of the fire control section verified but also the application of the data on the guns, so tracing the course of efficiency throughout the tactical chain. When the records are delivered by the range keepers, range setters, and the gun pointers, these men remain for the analysis; and as each man sees the work checked throughout the system he gains familiarity with the operation of the team as a whole and the relation his part bears to the others. And having the time element known, the effects of the various errors are computed, the proper corrected range of the target at the instant of firing each gun is determined by proportion, and—on the assumption that the guns shot perfectly—it is shown how many hits would have been made and who was responsible for any misses. This drill is also valuable for training men on foggy days, or when there is no target available, or during the indoor season. The next step is actual tracking on targets,

together with the keeping of records, in which the work is checked as before. Then when the target practice comes on the men are trained; records may be satisfactorily and readily kept without jeopardizing the accuracy of the battery by saddling upon the personnel at the eleventh hour this duty with which they may otherwise have no facility. And with the inevitable dissection of their work impending, each man may be relied upon to do his very level best.

To go more into detail, the records should be kept in the following or some similar form. The headings are here shown.

B′

Reader's Report (Date)

Azimuth	Differences	Azimuth	Differences

B″

Reader's Report (Date)

Azimuth	Differences	Azimuth	Differences

These reports give the successive readings from each station, and as one azimuth column is filled the record continues to the next azimuth column. The combined work of the observer and reader at each station is checked after the record has been turned in by taking the difference between each two successive readings, since the differences should be uniform or gradually increasing or gradually decreasing, depending upon the speed and the course of the target. Indelible pencil should be used, and the prohibition of erasures is recommended. Then if an azimuth is incorrectly read and recorded and transmitted, the source of the error is known; while there is no need of changing an azimuth correctly transmitted but erroneously recorded because the armsetter's record will show the proper reading as received.

No. 2 Armsetter's Report (Date)

Interval	Azimuths Received	Azimuths Set	Interval	Azimuths Received	Azimuths Set
1			21		
2			22		
3			23		

No. 3 Armsetter's Report (Date)

Interval	Azimuths Received	Azimuths Set	Interval	Azimuths Received	Azimuths Set
1			21		
2			22		
3			23		

The azimuths received are recorded in the column so headed, while the "Azimuths Set" are only noted where the readings received appear obviously erroneous by the time-azimuth travel relation and are not set as received. Before the plotted track is removed from the board, each setting should be remade to see that the record conforms with the track as plotted. Errors of the personnel or board are now eliminated by an inspection of the track as a whole. This can be done where necessary either by resetting the arms very carefully, or by working out the triangles trigonometrically or by making a particular plotted point line up with the contiguous portion of the track. The trigonometric method is of course much the slowest and is adaptable rather to a careful analysis of a practice than to a discussion of the work of a drill. Having the accurate actual ranges now available, the precise determination of the range travel and the wind reference number which should have been applied for each shot on the range board is next in order. The travel and wind are applied on the range board with the other values used for each position of the target and the total range correction is carefully computed, applied on the gun arm, and the corrected range thus determined. Throughout the checking, a running comparison and discussion of the original records is maintained. So the work of No. 4 is checked as given in his records. He records the several component values which go to make up the total range correction only when he applies a new correction. We now know the errors, if any, and their source in the range corrections.

No. 4's Report (Date)

Corrected Range	Tide	Atmosphere	Velocity	Wind	Travel	Range Correction	Time Applied

The form of the clerk's report is as follows:

Clerk's Report (Date)

Interval	Ranges Sent	Deflection Sent	Time of Sending	Time of Firing	Tactical No. of piece
1					
2					
3					
4					

In addition to recording the ranges and deflections sent by the plotter, he notes the times of sending the data, the times of

the discharges, and calls the interval from time to time in order to synchronise the records of the armsetters. He also tells the time to No. 4 at request. The battery commander or the emplacement officer will know the order in which the pieces were fired and can furnish that information. Having the time relation determined, we can find by proportion the position of the target on the track at the instant of firing, hence the proper corrected range from the directing point at the instant each shot is fired. In this way we find both the accuracy of the ranges sent and the elevations set for each shot on the data furnished and the amount of the range error of each shot which should be charged up against the personnel, not against the gun.

Range Setter's Report (Date)

Tactical No. of Piece	Number of Shot	Range Set	Displacement Correction

It is needless to say that the range setter can be held responsible only for the accuracy of his application of the time-range relation, including the displacement corrections, to the data sent him, not for the accuracy of the data itself. The object of recording the time that the ranges and deflections are sent (on the clerk's report) is to check the general smooth running of the personnel, and to see if the range setter possibly applied a range before the end of the interval in which received.

The deflections can be checked at the same time as the ranges by determining the true angular travel, either by carefully operating the gun arm or by trigonometry; then working out the proper wind reference number for each position of the target; then determining the correct deflection for each shot.

No. 5's Report (Date)

Interval	Range	Wind	Angular Travel	Deflection
1				
2				

The deflections and elements giving it are only recorded when the deflection changes materially, and then on the line corresponding to the interval.

Having conducted the daily drills as if actually in action, and having completed all the necessary preparations, the target practice itself becomes merely a demonstration by the company. Each man knows his duty and performs it with confidence. No matter at what position, he knows the extent to which the

success of the battery depends upon his individual effort. The whole body assigned to the battery is a smooth running team, and the only material variation from ordinary drill is that the guns are actually fired. That produces an unusual interest, but even under the inevitable excitement the habits inculcated by drill should overcome any effects of nervousness. For the officers there are no particularly unusual duties to perform under normal conditions. The battery commander assures himself that both observers are on the same point of the target, —such as the end mast of the target most sharply definable from both stations,—that everything has been done to secure the best meteorological data, then gives the command for tracking, etc. In giving the command "Commence firing," it may be well to mention the advantage from opening up with the leeward gun in case there is a breeze blowing across the front of the battery. Then if the splash of the second shot is taken as the time for giving the command to the other gun, the first gun to fire is all through before the other one can get its first shot off, and the gun pointer to the leeward is not bothered by smoke or dust. Further than this, the battery commander's hands are free to exercise general control, to see that all precautions for safety are observed, and to give such appropriate commands as an emergency may require. The range and emplacement officers take such measures as will assure the smooth running of the various details under their supervision. In general it may be stated that the best trained batteries require the fewest preparatory commands. And that is the ideal to be attained. Under the stress and accidents of an action a thousand and one things may happen to any system, and the most valuable company will be that one in which initiative of knowledge is most in evidence,—where the fall of superiors will not halt, or render ineffective, the various units normally under their control.

Let it be born in mind that any errors are, in the last analysis, the fault of the battery commander, in spite of any extenuating circumstances. If misses are made for some unforseen or unknown cause, let the battery commander plead ignorance and admit himself to be just so much short of mastering his profession. If misses are made by erroneous performances by members of the personnel, there is one person who is responsible for their lack of instruction. This hard view is generally the just view. And if hits cannot be made in the one-sided condition of target practice, what is to be expected

in action? The Coast Artillery is charged with the efficient service of the armament placed in their hands, and it is the plain duty of every officer and enlisted man in the corps to use every effort to keep us worthy of our trust.

STEAM BOILER TESTING

By Captain John O. Steger, Coast Artillery Corps

Instructor, Department of Engineering and Mine Defense
Coast Artillery School

The purpose of this paper is to supply a guide to student officers in the Department of Engineering and Mine Defense, Coast Artillery School, who are taking up for the first time the subject of boiler testing. With this object in view the data sheets made at a boiler trial by certain students of the Advanced Class of 1911 have been used as a basis for the calculations necessary in making out the form "Report of Boiler Test." Additional data desired was acquired by the writer at a later date. A brief explanation of each item of the report and calculations where considered desirable are given. Full descriptions may be found in the references cited.

The above mentioned form (which is an elaboration of Table I, Rules for Conducting Boiler Trials, A. S. M. E., code of 1899) and those of the data sheets were devised by Captain Offnere Hope, Coast Artillery Corps, and are now used for boiler trials made at the school.

The following instruments, when used, should be calibrated, or their freedom from error established:

Steam gages, pressure gages, thermometers, calorimeter, platform scales, water tank if feed water is measured by volume, fuel-gas-analysis apparatus.

(All calculations were made with a 20-inch slide rule.)

NOTES ON TEST

1. The "alternate" method of starting and stopping was used. (See "Explanation of Report" below.)

Conditions

Boiler pressure	Before test	115 lbs.
	After test	92 lbs.
Water Level	Before test	4.4 inches "Gage."
	After test	4.5 inches "Gage."

The boiler pressure should be the same at beginning and end of test.

2. All ash pit and furnace doors of boilers other than Boiler No. 2, were thoroughly sealed.

3. The feed water was weighed alternately in two G. I. tanks supported on platform scales and delivered from these tanks into a G. I. pump tank just below them. This tank was connected to the suction of the feed pump.

The water in going from the feed pump to the boiler passed through a "Venturi" water meter. Readings were made on this meter as a check on the weighing of the water on the scales.

The results obtained on the "Venturi" meter were not satisfactory, the results follow:—

Measurement of Water by "Venturi" Meter.

8:00 a.m.	Reading of meter..................	1,885,730 lbs.
8:00 p.m.	Reading of meter..................	1,999,170 lbs.
	Difference (or total amount used)...	113,440 lbs.
	Actual amount of water weighed ...	108,363 lbs.
	Meter error......................	+5,077 lbs. = 4.7%

(See data sheet)

4. The coal was weighed in lots of approximately 1000 lbs., and fired by shovel from coal car. (See data sheet.)

5. Calorimeter, temperature and pressure readings were taken every 15 minutes.

6. Flue-gas samples were taken and tested by "Orsat Apparatus" every hour. Readings on the "Sarco" apparatus gave the % of CO_2 in the flue-gas at any time during the test. (See data sheet.)

7. The fire was cleaned just before commencing the run (7:55 a.m.) and immediately preceding end of the test (7:55 p.m.). This operation required practically 12 minutes.

8. Nearly the entire test was made with the ash pit doors wide open. Data sheet under "air supply" gives the amount and time these doors were open during the test.

9. The readings under the heading "Temperatures—Feed Water" are 8 degrees F. too low. The feed water thermometer was calibrated after the test and found to have an error of —8 degrees F.

10. A difference of .1 inch of water in gage glass is equal to 50 lbs. of water in boiler.

11. The following events were noted during the firing:

A.M. 7:55—Cleaning of fire commenced.
8:15—Cleaning of fire completed.
8:30—Breeching damper partly closed.
9:45—Fire raked.
10:45—Fire raked.
11:25—Fire raked.
11:26—Fire sliced.
12:00—Damper closed.

P.M.
12:58—Draft in No. 1 furnace door opened.
2:00—Cleaning of fire commenced.
2:35—Cleaning of fire completed.
2:35—Drafts in all furnace doors opened.
3:52—Drafts in all furnace doors closed.
4:20—Ashes cleaned out of pit.
5:30—Fire raked.
5:45—Fire raked.
7:30—Pump leakage weighed, 110 — 39 = 71 lbs.

Report of Boiler Test, Coast Artillery School, *October 27, 1910.*

1.	*Evaporation* TEST OF BOILER NO. 2, C. A. SCHOOL		
2.	Date, *October 27, 1910.*		
3.	Made by—*1st Lieutenant O. Hope, C. A. C., assisted by Capts. Hasbrouck, Fuller, Steger, and Hines, Advanced*		
	Ash = *2.91%*		
	Sulphur =		
37.	Per cent. moisture, air dried in boiler room		*not taken*
38.	Lbs. coal fired		*12833*
39.	Lbs. dry coal fired $\left[No.\ 38\left(\frac{100-\%\ moisture}{100}\right)\right]$		*12630*
40.	Lbs. refuse and ash		*950*
41.	Percentage ash and refuse in dry coal $[(No.41 \div No.39) \times 100)]$		*7.52*
42.	Per cent. carbon in ash		*26*
43.	Per cent. earthy matter		*74*
44.	Kind of firing (spreading, alternate, coking, ribbon)		*Ribbon*
45.	Average thickness of fire	*in.*	*4 to 5*
46.	Average intervals between firings	*min.*	*5*
47.	Average intervals between cleanings	*hrs.*	*6*
48.	Lbs. combustible consumed $(No.\ 39 - No.\ 40)$		*11680*
49.	Combustible consumed per hour $(No.\ 48 \div 12)$	*lbs.*	*973*
50.	Combustible per sq. foot grate surface, per hour $(No.\ 49 \div No.\ 11)$	*lbs.*	*20.5*
51.	Dry coal consumed per hour $(No.\ 39 \div 12)$	*lbs.*	*1052*
52.	Dry coal burned per sq. ft. grate surface per hour $(No.\ 51 \div No.\ 11)$	*lbs.*	*22.15*
53.	Height of furnace, front, *3 feet* rear, *2 ft. 11 in.*		
86.	Hourly coal cost of developing 1000 B.H.P. $(No.\ 88 \times 1000 \times 0.0013)$		*$4.513*
87.	Cost of coal to evaporate 1000 lbs. water from and at 212° F. $[(1000 \div No.\ 81) \times 0.0013]$		*$0.1553*
88.	Lbs. coal so fired per hour per horse power developed $[(No.\ 38 \div 12) \div No.\ 89]$		*3.47*
89.	Horsepower developed, on basis of 34.5 lbs. water per hour from and at 212° F. $(No.\ 78 \div 34.5)$		*308.2*
90.	Builders rated H. P.		*272*
91.	Per cent. developed above or below builders H. P. rating	*above*	*13.3*
92.	Heating surface per horsepower developed $(No.\ 8 \div No.\ 89)$		*8.81*
93.	Efficiency boiler and grate $[(No.\ 77 \times 970.4) \div (38 \times 14350)] \times 100$	%	*67.2*
94.	Weather		*clear*
95.	Cost per B. H. P. per hour	cents	*0.488*

ERRATA

Report of Boiler Test.

Item 41.	No. 41 in formula should read No. 40.
Item 60.	O in $\frac{O}{8}$ is the symbol for oxygen.
Item 71.	70.8 should read 70.7.
Item 87.	No. 81 should read No. 83.
	$0.1553 should read $0.1306.
Item 81.	Omit last zero in result.
Item 82.	Omit last zero in result.
Item 93.	38 should read No. 38.

Wherever 12 appears in red figures it refers to item 6, duration of test.

12. The six (6) inch excess air pipe leading from the rear of boiler setting to bridge wall was open 1¼ inches during test.

13. Samples of coal were selected during the test in accordance with the following: As each portion of coal is taken from the coal bin for weighing a representative shovelful is selected and placed in a box in a cool place until the end of test. The samples are then well mixed and broken into pieces not exceeding one inch in diameter, and reduced by repeated quartering and crushing until a sample of about five pounds is obtained the pieces of which will pass through a ¼ inch mesh. From this sample fill two one-quart air-tight preserving jars, or other air-tight vessel which will prevent the escape of moisture from the sample. These samples to be kept for subsequent determinations of moisture and of heating value and for chemical analyses.

EXPLANATION OF REPORT

Item 1. The specific object of the test should be clearly defined and steadily kept in view. It may be to determine the capacity, efficiency as a steam generator (usually called "evaporation test"), efficiency under operating conditions, economy of a particular kind of fuel, effect of changes in design, proportion, or operation. The furnace of boiler used in this test was designed for anthracite coal. The test was made with semi-bituminous coal, with the object of comparing the efficiency and capacity with other tests using anthracite coal.

Item 2. This should include dates of start and finish.

Item 3. Names of person who conducted the test and assistants.

Item 4. Under this head should be described:

a. The method of starting and stopping, "standard" or "alternate."

b. Water levels and steam pressures at start and stop.

c. Condition of other boilers, if one of a battery, whether others are operated, connected to same steam main and flue, or cold with ashpits and furnace doors sealed. In fact, any condition that may affect the temperatures, pressures, or condition of steam, should be fully stated.

d. Methods of handling and measuring feed water and coal.

e. Recording interval, with explanation of any divergence.

f. Records of cleaning and slicing fire, with necessary explanations.

g. Description of means of obtaining draft, as stack, artificial, air ducts, or other accessories.

Extract from "Rules for Conducting Boiler Trials, Code of 1899, A. S. M. E.

IX. Starting and Stopping a Test.—The conditions of the boiler and furnace in all respects should be, as nearly as possible, the same at the end as at the beginning of the test. The steam pressure should be the same; the water level the same; the fire upon the grates should be the same in quantity and condition; and the walls, flues, etc., should be of the same temperature. Two methods of obtaining the desired equality of conditions of the fire may be used, viz.: those which were called in the Code of 1885 "the standard method" and "the alternate method," the latter being employed where it is inconvenient to make use of the standard method.

X. Standard Method of Starting and Stopping a Test.—Steam being raised to the working pressure, remove rapidly all the fire from the grate, close the damper, clean the ash pit, and as quickly as possible start a new fire

with weighed wood and coal, noting the time and the water level while the water is in a quiescent state, just before lighting the fire.

At the end of the test remove the whole fire, which has been burned low, clean the grates and ash pit, and note the water level when the water is in a quiescent state, and record the time of hauling the fire. The water level should be as nearly as possible the same as at the beginning of the test. If it is not the same, a correction should be made by computation, and not by operating the pump after the test is completed.

XI. Alternate Method of Starting and Stopping a Test.—The boiler being thoroughly heated by a preliminary run, the fires are to be burned low and well cleaned. Note the amount of coal left on the grate as nearly as it can be estimated; note the pressure of steam and the water level. Note the time, and record it as the starting time. Fresh coal which has been weighed should now be fired. The ash pits should be thoroughly cleaned at once after starting. Before the end of the test the fires should be burned low, just as before the start, and the fires cleaned in such a manner as to leave a bed of coal on the grates of the same depth, and in the same condition, as at the start. When this stage is reached, note the time and record it as the stopping time. The water level and steam pressures should previously be brought as nearly as possible to the same point as at the start. If the water level is not the same as at the start, a correction should be made by computation, and not by operating the pump after the test is completed.

Item 5. The number of boilers in battery and the number tested should be stated.

Item 6. The duration of test should be as long as practicable to minimize the errors due to varying conditions at start and stop, such as thickness of fire, pressure, load and radiation.

Item 7. Name of maker, and type, *i. e.*, water tube, fire tube, or cylindrical, through tube or return tubular, horizontal or vertical, internally or externally fired.

Item 8. The area of heating surface is the total surface of metal parts in contact with hot gases where the other side of the metal is in contact with water, such as shell, tubes, and water legs.

Items 9 and 10. These should be measured under direction of the person conducting the test. (See Fig. 5.)

Item 11. This is the product of length and width of grate and is expressed in square feet.

Item 12. Ratio of value in item 8 to that in item 11.

Item 13. This should include:

a. Class: stationary, rocking, travelling.
b. Type: tupper, herringbone, common bar, sawdust, or pin hole.
c. Shape: flat, inclined, step.
d. Patent name: Roney stoker, Dawson rocking grate, etc.

Item 14. This is the per cent. relation of the open spaces between grate bars (or in grate bars) to the total grate area (Item 11). It must be determined for each variety of grate.

Item 15. This is the distance in feet from dead plate to top of stack.

Item 16. This refers to the smallest cross section of stack, in square feet. It is usually at the top.

Item 17. Item 16 divided by item 11.

Item 18. The barometer should be recorded in inches of mercury. This may be reduced to lbs. per sq. in., by multiplying by 0.49, or dividing by 2.04. In the absence of a barometer the atmospheric pressure should be taken as 14.7 lbs. per sq. in.

Item 19. The steam gauge gives pressures in lbs. per sq. in. above atmospheric pressure. The atmospheric pressure in lbs. per sq. in. (item 18) must be added to this before using the steam tables with pressure as the argument.

Items 20, 21, 22, and 23. The draft gauges are read in inches of water. They will vary with the various coals, grates, load, manner of stoking, height of stack, character of flue, and whether other boilers are connected to the same flue. They indicate the uniformity of firing, and load, and are a guide for efficient daily operation.

Item 24. The temperature of the external air affects the force of draft and is recorded principally for that reason. It should be given in degrees F, which is the standard for mechanical engineers in America.

Item 25 and 26. Degrees F. These affect the heat lost in chimney gases, that due to moisture in coal, and the burning of H in coal to H_2O.

Item 27. Degrees F. This is used in calculating the factor of evaporation and the economy of certain accessories.

Item 28. Degrees F. This is used to calculate the weight of water when the latter is measured by volume.

Item 29. Degrees F. This is used in calculating the heat losses mentioned under items 25 and 26 above, and as an indication of proper air supply in daily operation.

Item 30. Degrees F. This indicates air leakage into the flue, and if one boiler only is installed, has the uses mentioned under item 29.

Item 31. To measure the temperature of the furnace a pyrometer is required, this is an expensive instrument and its accuracy doubtful. Good practice does not require its use.

Item 32. Kind of coal:

a. Class: Anthracite.
Semi-anthracite.
Semi-bituminous.
Bituminous.
Lignite.

b. Location of mine.

Item 33. Size of coal:

a. Anthracite, Egg must pass through 2¾-inch mesh and not through 2-inch mesh.

Stove must pass through 2-inch mesh and not through 1¼-inch mesh.

Chestnut must pass through 1¼-inch mesh and not through ¾-inch mesh.

Pea must pass through ¾-inch mesh and not through ½-inch mesh.

Buckwheat must pass through ½-inch mesh and not through ¼-inch mesh.

Rice must pass through ¼-inch mesh and not through ⅛-inch mesh.

b. Other coals, run of mine, or screenings.

Item 34. The Quartermaster Department now purchases coal by the ton (2240 lbs.). The cost should include delivery to the fire room.

Item 35. Ultimate analysis and heating value of coal should be obtained from the Bureau of Mines, to which a representative sample should be sent. The heating value may be determined by a bomb calorimeter, if at hand.

Determination of B.T.U. with "Emerson Bomb Calorimeter."

Weight of coal and pan	=6.9844 grams.
Weight of pan	=6.0801 grams.
Weight of coal	=0.9043 grams.
Weight of water	=1900 grams (in calorimeter)

Time	Temperature	
11:10	23.93 Deg. C	
11:10:30	.93 "	
11:00	.92 "	
:30	.92 "	
12:00	.91 "	
:30	.91 "	
13:00	.90 "	
:30	.90 "	
14:00	.90 "	
:30	.89 "	
15:00	.89 "	(Firing Temp.)
:30	24.88 "	
16:00	26.20 "	
:30	.65 "	
17:00	.83 "	
:30	.91 "	
18:00	.93 "	
:30	.94 "	
19:00	.94 "	
:30	.94 "	(Maximum Temp.)
20:00	.93 "	
:30	.92 "	
21:00	.92 "	
:30	.91 "	
22:00	.90 "	
:30	.89 "	
23:00	.88 "	
:30	.87 "	

Apparent rise in temperature $= 26.94 - 23.89 = 3.05°$ C.

Rate of change of temperature before firing $= \frac{23.93 - 23.89}{5} = .008 = R_1$.

Rate of change of temp. after max. temp. $= \frac{26.94 - 26.87}{5} = .014 = R_2$.

Average rate of change of temp. during run $= \frac{R_1 + R_2}{2} = \frac{.022}{2} = .011$.

Total cooling correction $= 3.5$ min. $\times .011 = .0385°$ C (additive).
Total corrected rise in temp. $= 3.05 + .0385 = 3.0885°$ C.
Rise per gram of sample $= 3.0885 \div 0.9043 = 3.415°$ C.
The water equivalent of bomb, calorimeter, stirrer, etc. $= 434$.
Gram calories per gram of sample $= (1900 + 434) \times 3.415 = 7975$.
B.T.U. per pound of sample $= 7975 \times 1.8 = 14350$.

At least five tests should be made and the average taken. Individual tests should not vary more than 0.3%.

$$\text{Dry coal} = \text{coal} - \left(\frac{\%\ \text{moisture}}{100}\right).$$

$$\text{Combustible} = \text{coal} - \left(\frac{\%\ \text{moisture} + \%\ \text{ash}}{100}\right)$$

$$\frac{14350}{1.00 - 0.016} = 14580 \text{ B.T.U. per lb. dry coal.}$$

$$\frac{14350}{1.00 - (0.016 + 0.029)} = 15025 \text{ B.T.U. per lb. combustible.}$$

Item 36. MOISTURE. (Jour. Am. Chem. Soc., 1899.)

Dry about one gram of coal sample in an open crucible at 104°-107° C for one hour. Cool in a dessicator and weigh covered. Loss in weight is moisture.

Sample No. 1.

Placed in oven 10:20	Wgt. of glass crucible	=12.4639 grains	
	Wgt. of glass and coal	=18.0437 "	
Removed from oven 12:00	Wgt. of glass and coal	=17.9508 "	
	Difference	= 0.0929 "	=1.7%

Sample No. 2.

Placed in oven 10:20	Wgt. of glass crucible	=12.3799 "	
	Wgt. of glass and coal	=19.4865 "	
Removed from oven 11:50	Wgt. of glass and coal	=19.3727 "	
	Difference	= 0.1138 "	=1.6%

Sample No. 3.

Placed in oven 10:30	Wgt. of glass crucible	=12.3783 "	
	Wgt. of glass and coal	=18.2372 "	
Removed from oven 11:45	Wgt. of glass and coal	=18.1445 "	
	Difference	= 0.0927 "	=1.6%

PROXIMATE ANALYSIS. (Jour. Am. Chem. Soc., 1899.)

The per cent. of moisture having probably changed before the proximate analysis was made it was again determined here.

Moisture.

Watch glass + coal	=36.0320 grams.
Watch glass	=34.6901 "
Coal	= 1.3419 "

After drying in oven between 104° and 107° C for one hour

Watch glass + coal (above)	=36.0320 grams.
Watch glass + dry coal	=36.0178 "
Difference	= 0.0142 "

$$\frac{0.0142}{1.3419} \times 100 = 1.06\% \text{ moisture.}$$

Good practice requires at least three determinations, but the above agreed so closely with others made by students at the same time, that it was assumed to be correct.

Ash.

Platinum crucible + coal	=12.5440 grams.
Platinum crucible	=12.0386 "
Coal	= 0.5054 "

After heating five hours over bunsen burner,

Crucible + ash	=12.0533 grams.
Crucible (above)	=12.0386 "
Ash	= 0.0147 "

$$\frac{0.0147}{0.5054} \times 100 = 2.91\% \text{ ash, (usually designated "Laboratory Ash").}$$

Volatiles.

Platinum crucible and top + coal	=15.7656 grams.
Platinum crucible and top	=14.7278 "
Coal	= 1.0378 "

This was heated for seven minutes 3¾ inches above a Bunsen burner whose free flame was 7½ inches high (should be 8 c. m. and 20 c. m. respectively).

Crucible and top + coke	=15.4936 grams.	
Crucible and top	=14.7278 "	
Coke	= 0.7658 "	
Coal	= 1.0378 "	
Volatiles + moisture	= 0.2720 "	
Moisture	= 0.0111 "	= 1.0378 × 0.0106
Volatiles	= 0.2609 "	

$$\frac{0.2609}{1.0378} \times 100 = 25.12\% \text{ volatiles.}$$

Coke	= 0.7658 grams.	
Ash	= 0.0302 "	= 1.0378 × 0.0291
Fixed carbon	= 0.7356 "	

$$\frac{0.7356}{1.0378} \times 100 = 70.88\% \text{ fixed carbon.}$$

Item 37. A sample of about 50 lbs., obtained is indicated in "Notes on Test," may be placed in the hottest place that can be found on the brickwork of the boiler settings or flues for 12 hours. The loss in weight is moisture. This method is crude, but is probably the best available at army posts.

Item 38. Actual weight of coal as fired. (See "Notes on Test" and data sheet.)

Item 39. Lbs. dry coal as fired = lbs. coal fired × [1.00 — moisture (decimal fraction)]. The % moisture should be as nearly as practicable that in the coal during the test. In the test here described the % moisture was determined from several representative samples on the day following the test. The % moisture determined later during the proximate analysis did not agree with the above and was not used, as the jar containing the powdered sample had been opened several times and the latter may easily have absorbed or liberated moisture.

Item 40. Refuse and ashes removed during the test should be weighed when cool (and dry). Immediately after completion of test the ash pit should be cleaned and the contents weighed as soon as cool (and dry). The total refuse and ash includes all that is removed from ashpit during, and at end of, test.

Item 41. Item 40 divided by item 39 and multiplied by 100.

Item 42. Per cent. of carbon = refuse and ash multiplied by [(100 — earthy matter (decimal fraction)].

Item 43. Earthy matter determined as in "determination of ash" (item 36).

Item 44. *Spreading*, each fresh charge covers entire grate evenly.
Alternate, charges of fresh coal are thrown alternately on right and left half of grate.
Coking, charges of fresh coal placed near dead plate and pushed back when coked.
Ribbon, charges of fresh coal are placed on the fuel bed in several longitudinal strips. The number of strips depend on the size of grate. The spaces between strips are of the same width as the strips.

Item 45. Estimated average thickness of fuel bed at time of recording.

Item 46. Interval in minutes between times of placing fuel on fire

Item 47. Average interval between cleanings of fire. This means thorough cleaning of entire fuel bed and not simply breaking clinkers, raking or slicing to remove loose ashes from grate. Half of the fire only should be cleaned at a time, front, rear, or either side. To reduce drop in pressure while cleaning, raise boiler pressure and water level and stop feed.

Item 48. This is the number of pounds difference between dry coal, fired, and the total refuse and ash removed from the ash pit, (item 39 less item 40).

Item 49. Item 48 divided by hours duration of test.

Item 50. Item 49 divided by the area of grate surface in sq. ft. (item 11).

Item 51. Item 39 divided by hours duration of test.

Item 52. Item 51 divided by the area of grate surface in sq. ft. (item 11).

Item 53. Height of furnace from dead plate to baffle wall (or boiler shell, or tubes, if exposed to hot gases) at front and back.

Item 54. Width of air space in grate in inches. If irregular, the average width should be determined.

Item 55. This is the ratio of the minimum cross section of the flue, through which hot gases reach the stack, to the area of the grate, (item 11), both expressed in sq. ft.

Item 56.

	% Vol.		Molecular Wgt.				
CO_2 =	12.47	×	44/2 =	274.4	12/44 × 274.4 =	74.9 of C
O_2 =	5.33	×	32/2 =	85.3		
CO =	0.64	×	28/2 =	9.0	12/28 × 9.0 =	3.9 of C
				368.7		78.8 total C
				78.8		
				289.9	total O_2	

289.9/78.8 = 3.68 lbs. of O per lb. of C.

3.68/0.23 = 16 lbs. of air per lb. of C.

16.00 × 0.8105 = 12.96 lbs. of air required by C in 1 lb. coal.

Each lb. of H burned requires 8 lbs. of O. Since there is about 23% of O in air, then $\frac{8}{0.23} = 35$ lbs. air to burn 1 lb. H to H_2O. It is assumed that the O in coal forms H_2O with 1/8 its weight of H.

36 lbs. of air are taken instead of 35 as found above to accord with item 60 of the report.

36 (0.0491 — 0.0457/8) = 1.56 lbs. air to burn H in 1 lb. coal.

12.96 + 1.56 = 14.52 lbs air per lb. dry coal.

Item 57. An anemometer is sometimes installed in the ashpit door for determining the velocity of air, the size of door and temperature of air being known, the total pounds of air used may be calculated. This is not usually done. (See item 56.)

Item 58. This may be determined by means of the wet and dry bulb thermometers maintained at Coast Artillery forts under the Ordnance Officer. The moisture in the atmosphere has a small effect on the thermal efficiency of grate and boiler. It is not usually considered.

Item 59. $\frac{14.52-11.10}{11.10} \times 100 = 30.8\%$ excess air (see items 56 and 60).

Item 60. Air required for theoretically perfect combustion (assuming 2% of carbon unburned in ash),

$$81.05 \times 0.98 \times 12 + 36\left(0.0491 - \frac{0.0457}{8}\right) = 11.10 \text{ lbs. air per lb. dry coal.}$$

Item 61. See "data sheet" and JOURNAL U. S. ARTILLERY, March-April, 1910.

Item 62. Average % of CO_2 as determined from the record of Sarco CO_2 Combustion Recorder (see "data sheet" and JOURNAL U. S. ARTILLERY, January-February, 1909). This apparatus is not usually installed in power plants at coast artillery posts.

Item 63. Observations were made each minute from 8 a.m. to 5:44 p.m., when it became too dark for accurate observations, on Ringelmann's smoke chart, 8 inches square and of the description given below. (See Fig. 6.) These may be obtained from the Secretary, Coast Artillery School. The charts should be at least fifty feet from the observer, at which distance the lines are invisible.

No. 0 = 0% black = white.

1 = 20% black = black lines 1 m.m. thick, 10 m.m. apart, spaces 9 m.m. square.

2 = 40% black = black lines 2.3 m.m. thick, 10 m.m. apart, spaces 7.7 square.

3 = 60% black = black lines 3.7 m.m. thick, 10 m.m. apart, spaces 6.3 m.m. square.

4 = 80% black = black lines 5.5 m.m. thick, 10 m.m. apart, spaces 4.5 m.m. square.

5 = 100% black = black.

The chart number multiplied by 20 obviously gives the per cent. of black to a close approximation, since the percentages given are not exact.

The chart number corresponding to average blackness of smoke is,

Chart.		No. observations.		
0	×	45	=	0
1	×	105	=	105
2	×	87	=	174
3	×	106	=	318
4	×	123	=	492
5	×	118	=	590
15		584		1679

$$\frac{1679}{584} = 2.87 \text{ average chart number.}$$

$2.87 \times 20 = 57.4\%$ black in smoke.

Item 64. See item 35.

Item 65. (See items 36, 56 and 61.)

14.52 lbs. air per lb. coal
0.79 lbs. C per lb. coal (0.81×0.98)
0.02 lbs. N per lb. coal

15.33 lbs. chimney gas per lb. coal.

$$\left.\begin{array}{lcrcr} & & \text{\% Vol.} & \text{Molecular Weight} & \\ CO_2 & = & 12.47 \times & \dfrac{44}{2} = & 274.4 \\ O_2 & = & 5.33 \times & \dfrac{32}{2} = & 85.3 \\ CO & = & 0.64 \times & \dfrac{28}{2} = & 9.0 \\ N_2 & = & 81.56 \times & \dfrac{28}{2} = & 1141.5 \end{array}\right\} \text{proportions by weight}$$

$$1510$$

$$\frac{274.4}{1510} \times 15.33 = 2.79 \text{ lbs. } CO_2 \text{ per lb. coal.}$$

$$\frac{85.3}{1510} \times 15.33 = 0.87 \text{ lbs. } O_2 \text{ per lb. coal.}$$

$$\frac{9.0}{1510} \times 15.33 = 0.09 \text{ lbs. } CO \text{ per lb. coal.}$$

$$\frac{11.42}{1510} \times 15.33 = 11.60 \text{ lbs. } N_2 \text{ per lb. coal.}$$

Weight	× specific heat	× temperature rise	= B.T.U. lost.
2.79	0.2169	542.5	= 328.3
0.87	0.2175	542.5	= 102.6
0.09	0.2450	542.5	= 12.5
11.60	0.2438	542.5	= 1535.0

B.T.U. lost per lb. dry coal = 1978

$$\text{B.T.U. lost per lb. combustible} = \frac{1978}{0.955} = 2071$$

Item 66. Equivalent evaporation from and at 212° per pound of combustible burned (item 85) multiplied by 970.4 (which is the number of B.T.U. required to evaporate one pound of water at 212° F into steam at 212° F and atmospheric pressure, "Steam Tables and Diagrams, Marks and Davis, 1909").

Item 67. Moisture referred to combustible,

$$\text{combustible} = \text{coal} - \left(\frac{\%\text{ moisture} + \%\text{ ash}}{100}\right) = 1.0 - (0.016 + 0.029) = 0.955$$

$$\frac{\%\text{ moisture}}{0.955} = \frac{1.6}{0.955} = 1.68\%\text{ moisture referred to combustible.}$$

Loss due to moisture,

$$0.0168 \times [(212 - t) + 970.4 + 0.48\ (T - 212)] = 22 \text{ B.T.U.}$$

T = 638.4 uptake temp. F.
t = 95.9 temp. air entering ashpit F.

Item 68. Per cent. of H referred to combustible,

$$\frac{\%H}{0.955} = \frac{4.91}{0.955} = 5.14\%\text{ (see items 35 and 67).}$$

Loss due to burning H to H_2O,

$$0.0514 \times 9 \times [(212 - t) + 970.4 + 0.48\ (T - 212)] = 597 \text{ B.T.U.}$$

Item 69. Loss due to incomplete combustion of carbon.

$$\frac{\%CO}{\%\ CO_2 + \%CO} \times \frac{\%C\text{ in combustible}}{100} \times 10150$$

$$\%C\text{ in combustible} = \frac{81.05}{0.955} = 83.8. \quad \text{(See items 35 and 67)}$$

$\%CO$ and $\%CO_2$ refer to volume (see item 61).

10150 is the number of B.T.U's. generated in burning 1 lb. C in CO to CO_2;

therefore

$$\frac{0.64}{12.47 + 0.64} \times 0.838 \times 10150 = 415.0 \text{ B.T.U.}$$

Item 70. B.T.U. supplied per pound of combustible burned (item 64), minus B.T.U. accounted for (sum of items 65 to 69 inclusive).

Item 71. Heat taken up by water per pound of combustible, divided by heat supplied per pound of combustible, the quotient multiplied by 100,

$$\frac{\text{item } 66}{\text{item } 64} \times 100$$

Item 72. The quality of steam is determined at each recording period, by means of a steam calorimeter (throttling or separating).

The graphic chart (Experimental Engineering, Carpenter), having steam temperature and calorimeter temperature as arguments may be used to find the average quality from the average temperatures, with greater accuracy than will be obtained by averaging the qualities found at the recording periods, since on this chart the quality curves are straight lines.

This is not the case on the other graphic chart whose arguments are steam pressure and calorimeter temperature.

Item 73. Factor of evaporation.

(Dry steam)

$F = \frac{(\lambda - t + 32)}{970.4}$; F = factor of evaporation.

λ = total heat of 1 lb. dry steam at observed pressure.

t = temperature of feed water degrees F.

(Wet steam)

Same as above with the following factor entered in the equation as given.

$\lambda = xr + q$; q = heat in liquid at observed pressure.

x = quality of steam.

r = latent heat of evaporation at observed pressure.

(Superheated steam)

$\lambda = xr + q + C_p ts$; C_p = specific heat of superheated steam at constant pressure.

ts = superheat in °F.

therefore

$$xr + q = (99.2 \times 871.5) + 319.5 = 1183.9$$

$$F = \frac{xr + q - t + 32}{970.4} = \frac{1183.9 - 71.6 + 32}{970.4} = 1.179$$

Item 74. Average temperature of steam, F. This is determined by thermometer, or from steam tables with the pressure as argument; if the steam is very wet, or superheated, the latter method introduces errors.

Item 75.

Total water weighed = 108,363 lbs.

Pump leakage = 71 lbs.

Amount of water in boiler above that at beginning of run = 50 lbs.

108,363 — (71 + 50) = 108,242 lbs. of water fed to boiler and evaporated.

Item 76. Weight of water fed to boiler (item 75) multiplied by the per cent. of dry steam (item 72 divided by 100).

Item 77. Item 75 multiplied by item 73.

Item 78. Item 77 divided by hours duration of test.

Item 79. Item 78 divided by sq. ft. heating surface (item 8).

Item 80. Item 78 divided by item 11.

Item 81. Item 76 divided by item 38.

Item 82. Item 76 divided by item 39.

Item 83. Item 77 divided by item 38.

Item 84. Item 77 divided by item 39.

Item 85. $\frac{127,600 \text{ (item 77)}}{11,680 \text{ (item 48)}} = 10.93$, equivalent evaporation from and at 212° F, per lb. combustible burned.

Item 86. $\frac{\$2.60}{2000} = \$0.0013$ cost per lb. coal (see item 34).

3.47 (item 88) $\times$ 0.0013 $\times$ 1000 = \$4.513 cost per 1000 B.H.P. hour.

Item 87. 1000 divided by item 83 and multiplied by cost per pound coal (0.0013 cents).

Item 88. Pounds of coal fired divided by hours duration of test, the quotient to be divided by horsepower developed, [(item 38 ÷ 12) ÷ item 89].

Item 89. Equivalent evaporation from and at 212° per hour, divided by 34.5 lbs. water, (item 78 ÷ 34.5).

Item 90. Contractor's statement of rating.

Item 91. $\frac{308.2 - 272}{272} \times 100 = 13.3\%$ developed above builder's rating.

Item 92. Item 8 divided by item 89.

Item 93. The efficiency of the boiler, including grate, or efficiency based on coal is

$$\frac{\text{Heat absorbed by boiler}}{\text{Heat in coal fired}} \times 100 = \frac{\text{item 77} \times 970.4}{\text{item 38} \times 14350} \times 100 = \frac{127600 \times 970.4}{12833 \times 14350} \times 100 = 67.2\%.$$

The efficiency of the boiler not including grate, or efficiency based on combustible, or thermal efficiency, is

$$\frac{\text{Heat absorbed by boiler}}{\text{Heat in combustible burned}} \times 100 =$$

$$\frac{\text{heat absorbed by boiler per lb. combustible burned}}{\text{Heat per lb. combustible}} \times 100 =$$

$$\frac{\text{item 66}}{\text{item 64}} \times 100 = \frac{10630}{15025} \times 100 = 70.7\%.$$

When a boiler is tested to determine the efficiency of the combination of boiler, furnace, and grate, "efficiency based on coal" should be used. When the test is for efficiency of boiler as a heat absorber, or to compare with other boilers, "efficiency based on combustible" should be used.

Item 94. Condition of the weather, clear, cloudy, damp, rain, snow, or other condition which would affect draft or losses.

Item 95. Cost per B.H.P. hour:—

Cost of coal, $\frac{\$4.513}{1000} = 0.451$ cents. (See item 86.)

Cost of water, (see item 75);

$71.6°\ F$ = temp. feed water = 62.3 lbs. per cu. ft.

$$\frac{62.3}{1728} \times 231 = 8.32 \text{ lbs. per gal.}$$

$$\frac{108{,}242}{8.32} = 13{,}010 \text{ gals.} = \text{total gals. used.}$$

Water costs 10.5 cents per 1000 gals.

$$13{,}010 \times \frac{10.5}{1000} = 136.6 \text{ cents, total cost of water.}$$

$$\frac{136.6}{12 \times 308.2} = 0.037 \text{ cents per B.H.P. hour.}$$

Cost of coal	= 0.451 cents.	
Cost of water	= 0.037 "	
	0.488 "	total cost per B.H.P. hour.

HEAT BALANCE

(See item 65) Heat carried off by flue gas per lb. combustible =

$$\frac{2071}{15025} \times 100 = 13.8\%$$

(See item 66) Heat taken up by water in boiler per lb. combustible =

$$\frac{10630}{15025} \times 100 = 70.7\%$$

(See item 67) Heat lost due to moisture in coal per lb. combustible =

$$\frac{22}{15025} \times 100 = .1\%$$

(See item 68) Heat lost by burning H in coal to H_2O per lb. combustible =

$$\frac{597}{15025} \times 100 = 4.0\%$$

(See item 69) Heat lost by incomplete combustion per lb. combustible =

$$\frac{415}{15025} \times 100 = 2.8\%$$

(See item 70) Radiation and unaccounted for losses per lb. combustible =

$$\frac{1290}{15025} \times 100 = 8.6\%$$

Total, 100.0%

CHARTS

The following charts are similar to ones used by Capt. Hope during the test.

The Graphic Log (*Fig. 1*) is drawn to show the variations in the most important items recorded during the test. This chart should always accompany the Report of Test, and may be constructed progressively during the test as an indication of the uniformity of conditions.

The Air Supply Chart (*Fig. 2*) is used to facilitate the determination of the air actually supplied expressed as a percentage of the volume of air re-

quired for theoretically perfect combustion. Per cent. excess air, the usual term, is the above percentage less 100.

The chart may be used to determine the excess air actually used at any time during tests or daily operation.

Having previously determined what per cent. of excess air gives the highest efficiency for the grade of coal used, the above will indicate whether more or less air should be admitted to the furnace.

The Chart for Indicating Efficiency and Evaporation (*Fig. 3*) is used to indicate the efficiency of the boiler and grate combined, and the apparent

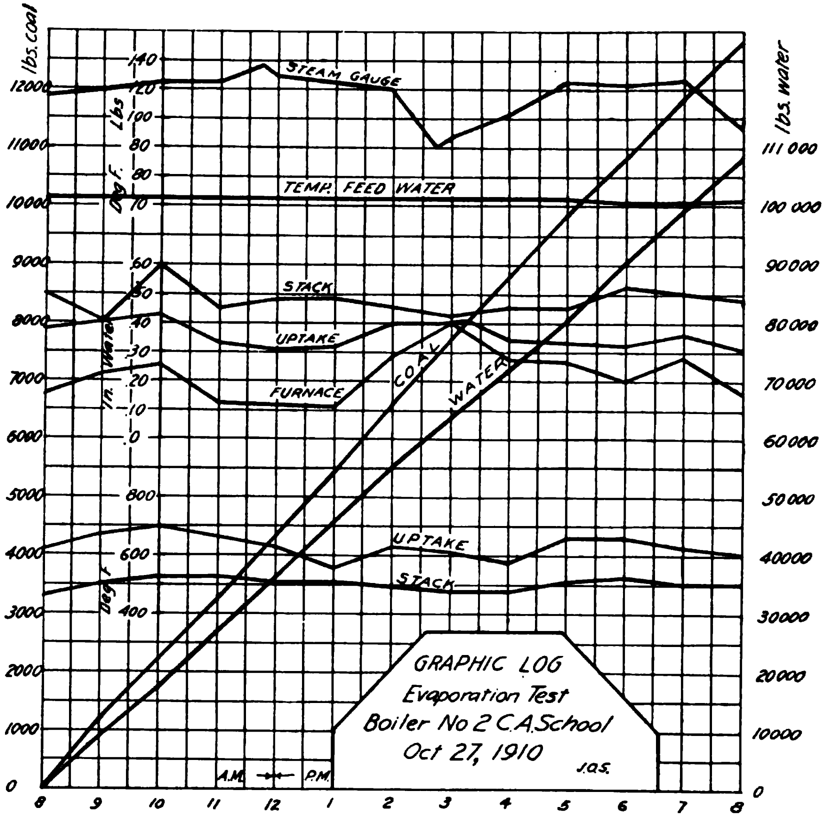

Fig. 1.

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evaporation per pound of coal from the hourly quantities of coal and water used. The "Boiler Horsepower" is also indicated from the pounds of water evaporated per hour. The chart was constructed before the heat value of the coal was determined. Similar coal had prevoiusly given 14280 B.T.U. per pound.

Flow of Air Through 6-inch Pipe (*Fig. 4*).—In burning bituminous coals which are high in volatiles, it is difficult to supply the required quantity of air through the fuel bed and at the same time maintain the bed sufficiently thick for desired loads. In this case air is sometimes supplied through

auxiliary ducts which pass through the combustion chamber, ashpit, or part of the furnace, in order to preheat the air, and terminate in the bridgewall, supplying at that point the oxygen required to burn the carbon and carbon monoxide (C and CO) in the uncombined gases to carbon dioxide (CO_2).

In the boiler tested a 6-inch pipe was installed, entering at the rear ash door, passing through the combustion chamber, and terminating in the interior of the hollow bridgewall, from whence air entered the combustion chamber through holes.

The chart is used to determine the quantity of air supplied through the 6-inch pipe, or the amount of coal this air will burn under the conditions indicated at the bottom of chart, the argument being the furnace draft in inches of water. The usual convention of plotting the known quantity (draft) as abscissas, has been departed from for convenience in lettering.

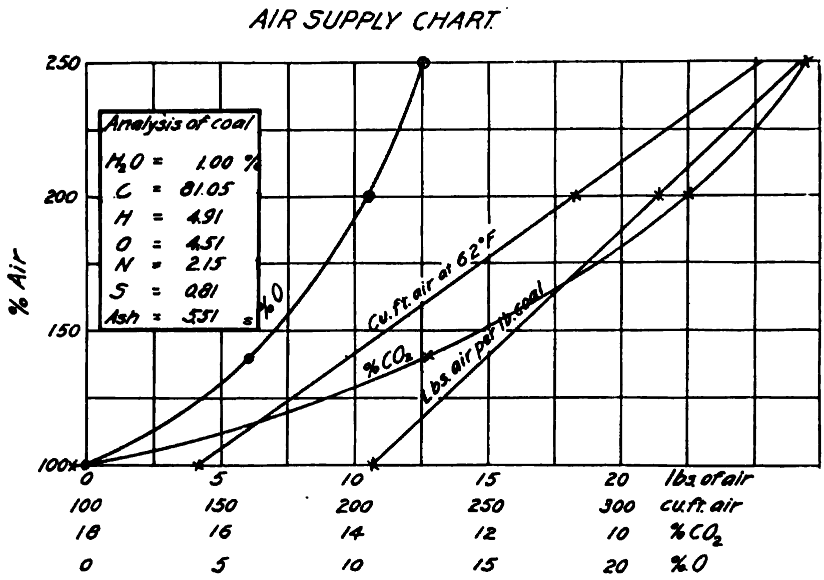

FIG. 2.

Calculations for Air Supply Chart.

Atomic weight of C = 12
Atomic weight of O = 16
Atomic weight of S = 32
Atomic weight of H = 1

$$C + O_2 = CO_2 \quad \text{1 pound C requires } \frac{2 \times 16}{12} = 2.67 \text{ lbs. O.}$$

$$H_2 + O = H_2O \quad \text{1 pound H requires } \frac{16}{2} = 8.00 \text{ lbs. O.}$$

$$S + O_2 = SO_2 \quad \text{1 pound S requires } \frac{2 \times 16}{32} = 1.00 \text{ lbs. O}$$

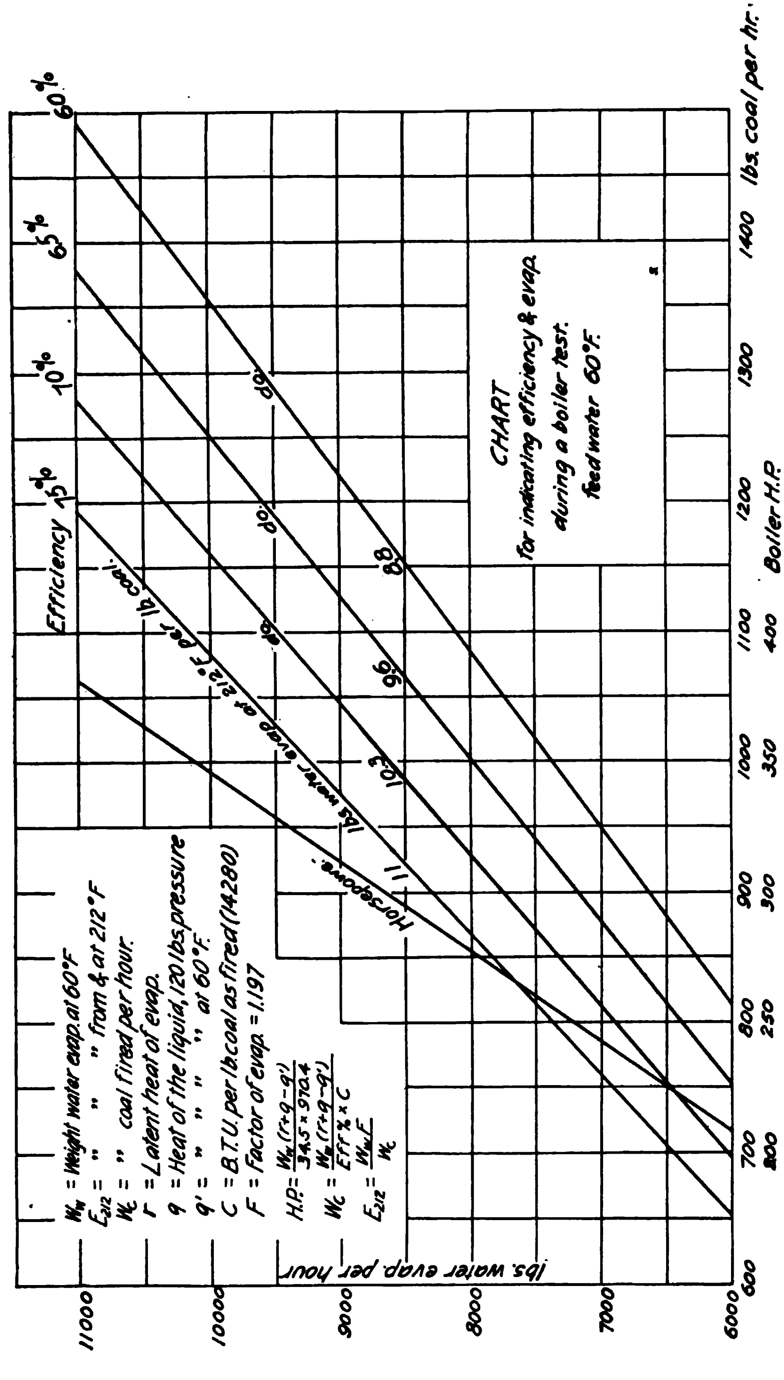
CHART
for indicating efficiency & evap.
during a boiler test.
feed water 60°F.
Efficiency
60%
65%
70%
75%
lbs. water evap. at 212° F per 1 lb. coal.
8.8
9.6
10.3
11
Horsepower
W_w = Weight water evap. at 60°F
E_{212} = " " " from & at 212°F
W_c = " coal fired per hour.
r = Latent heat of evap.
q = Heat of the liquid, 120 lbs. pressure
q' = " " " " at 60°F.
C = B.T.U. per lb. coal as fired (14280)
F = Factor of evap. = 1.197
$H.P. = \frac{W_w(r+q-q')}{34.5 \times 970.4}$
$W_c = \frac{W_w(r+q-q')}{Eff\% \times C}$
$E_{212} = \frac{W_w F}{W_c}$
lbs. water evap. per hour
6000
7000
8000
9000
10000
11000
600
700
800
900
1000
1100
1200
1300
1400
lbs. coal per hr.
200
250
300
350
400
Boiler H.P.
1003

FIG. 3.

Analysis of coal used (Georges Creek, New River) furnished by dealer:—

$$
\begin{aligned}
H_2O &= 1.00\% \\
C &= 81.05\% \\
H &= 4.91\% \\
O &= 4.57\% \\
N &= 2.15\% \\
S &= 0.81\% \\
\text{Ash} &= 5.51\%
\end{aligned}
$$

2% carbon assumed to fall through the grate.

O required per pound coal for theoretical combustion:—

lbs. C = 0.8105 × .98 = 0.794	0.794 × 2.67	= 2.12
lbs. H = 0.0491	0.049 × 8	= 0.39
lbs. S = 0.0081	0.008 × 1	= 0.01
		2.52
		0.046 lbs. O in 1 lb. coal.
		2.47 O supplied by air per lb. coal.

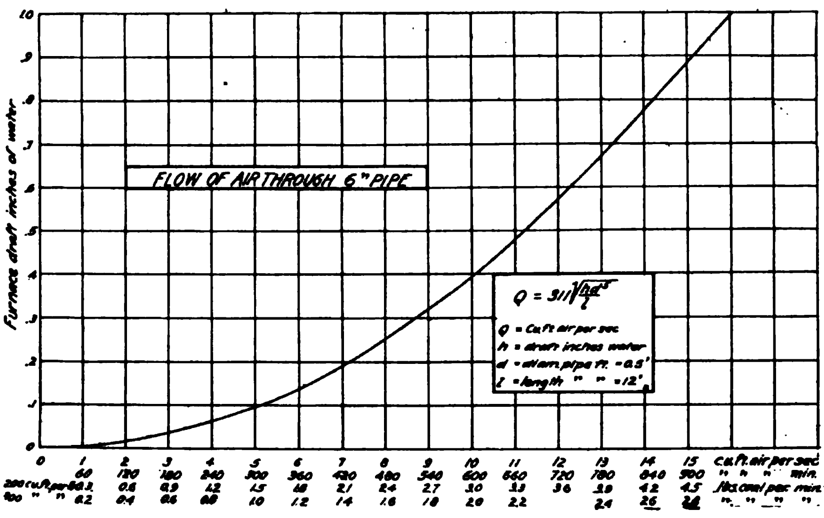

FIG. 4.

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$$\text{Air} = 23\ O + 77\ N \text{ by weight, approx.}$$
$$\text{Air} = 21\ O + 79\ N \text{ by volume, approx.}$$

$$1 \text{ lb. O} = \frac{100}{23} \text{ lbs. air.}$$

$$\frac{100}{23} \times 2.47 = 10.74 \text{ lbs. air. per lb. coal.}$$

1 lb. air = 13.16 cu. ft. at 62° F and 30" barometer.

10.74 × 13.16 = 141.4 cu. ft. of air per lb. coal.

Composition of flue gases when one pound of above coal is burned with varying quantities of air at 62° F and 30" barometer. (Steam Power Plant Engineering, Gebhardt, Edition 1910, p. 22.)

* Last four numbers on this line should be 2.4, 2.6, 2.8 and 3.0.

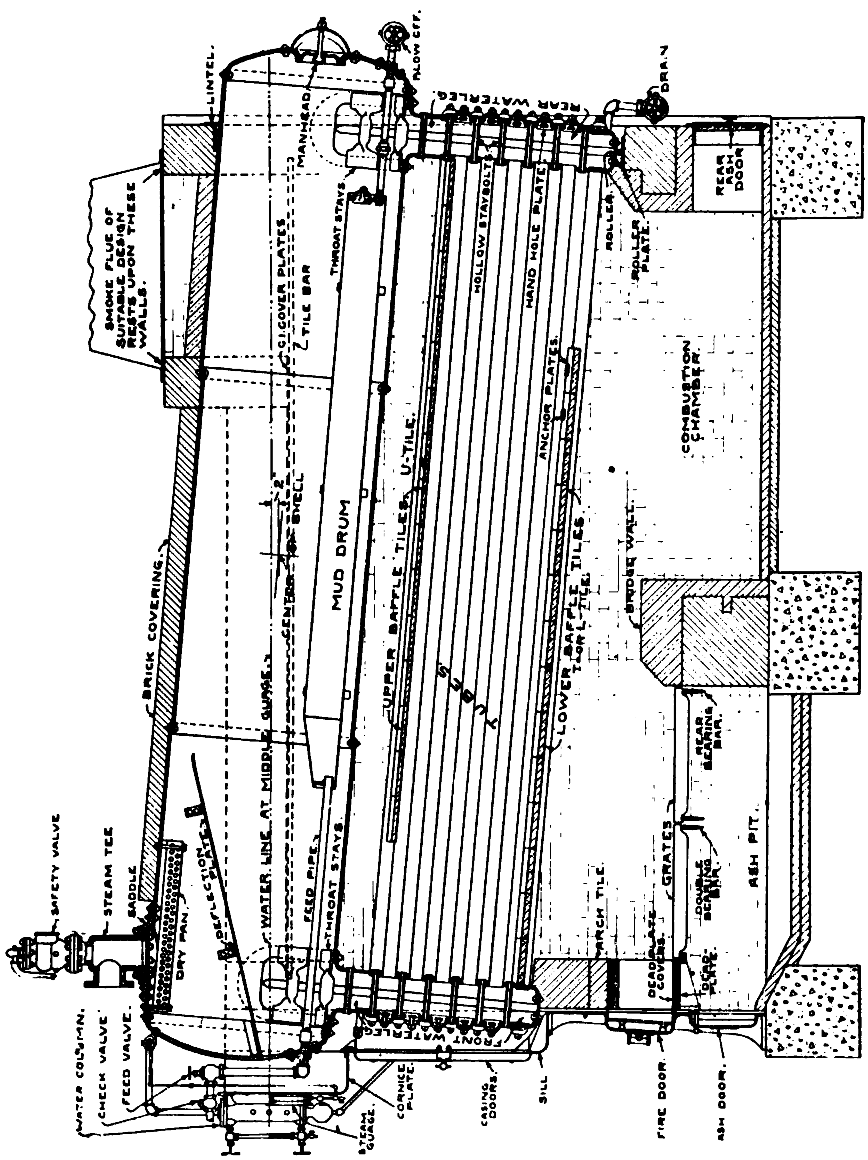


Illustration reproduced from catalog of Heine boilers.

FIG. 5.

100% Air (complete theoretical combustion).

0.79 lbs. C in 1 lb. coal burned.
2.12 lbs. O to burn C to CO_2.

2.91 lbs. CO_2 from 1 lb. coal.
8.63 cu. ft. per lb. CO_2 at 62° F and 30″ barometer.

25.11 cu. ft. CO_2 from 1 lb. coal.

0.008 lbs. S in 1 lb. coal.
0.008 lbs. O to burn S to SO_2.

0.016 lbs. SO_2 from one lb. coal.
0.02
5.93 cu. ft. per lb. SO_2 at 62° F and 30″ barometer.

0.12 cu. ft. SO_2 from 1 lb. coal.

0.02 lbs. N in 1 lb. coal.
8.27 lbs. N in air supplied per lb. coal (10.74 — 2.47).

8.29
13.55 cu. ft. per lb. N at 62° F and 30″ barometer.

112.4 cu. ft. N from 1 lb. coal.

25.11 cu. ft CO_2 = 18.2%
0.12 cu. ft. SO_2 =
112.4 cu. ft. N = 81.8%
137.6

140% Air.

$10.74 \times 1.40 = 15.03$ lbs. air per lb. coal.
$15.03 \times 0.23 = 3.46$ lbs. O in air per lb. coal.
$15.03 \times 0.77 = 11.58$ lbs. N in air per lb. coal.

3.46 lbs. O in air per lb. coal.
0.05 lbs. O in 1 lb. coal.

3.51 Total O supplied per lb. coal.
2.52 lbs. O in products of combustion.

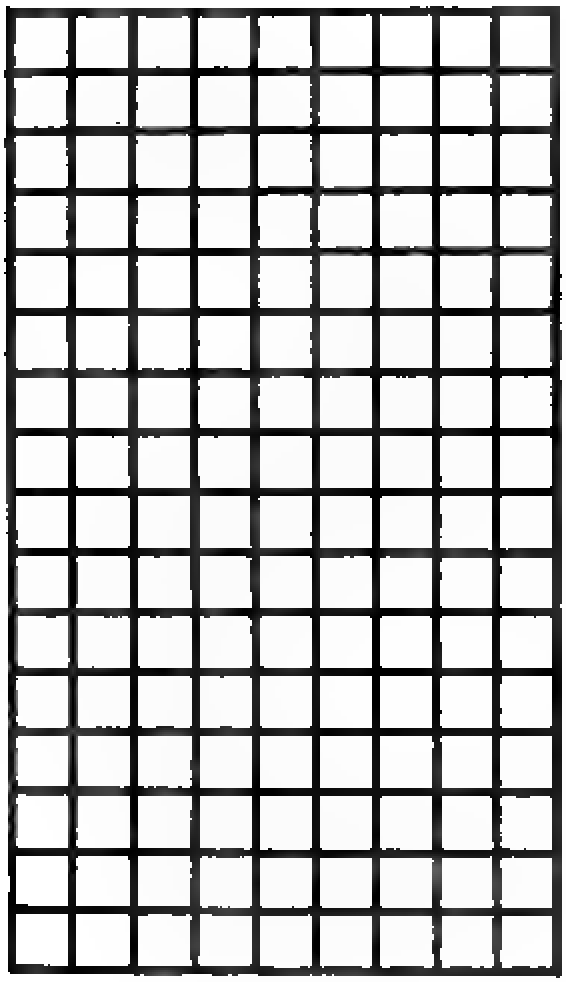
0.99 lbs. free O in chimney gases per lb. coal.
11.96 cu. ft. per lb. O (62° F and 30″ barometer).

11.84

11.58 lbs. N in air per lb. coal.
0.02 lbs. N in 1 lb. coal.

11.60 lbs. N in chimney gases per lb. coal.
13.55 cu. ft. per lb. N (62° F and 30″ barometer).

157.2 cu. ft. N in chimney gases per lb. coal.



No. 1.

No. 2.

No. 3.

No. 4.

FIG. 6.

1006

11.84 cu. ft. O = 6.1%
157.2 cu. ft. N = 81.0%
25.11 cu. ft. CO_2 = 12.9%
0.12 cu. ft. SO_2 =

194.3

200% Air.

$10.74 \times 2.0 = 21.48$ lbs. air.
$21.48 \times 0.23 = 4.94$ lbs. O.
$21.48 \times 0.77 = 16.54$ lbs. N.

4.94	165.4	
0.05	0.02	29.54 cu. ft. O = 10.6%
		224.3 cu. ft. N = 80.4%
4.99	16.56	25.11 cu. ft. CO_2 = 9.0
2.52	13.55	0.12 cu. ft. SO_2 =
2.47	224.3	279.07
1.96		
29.51		

250% Air.

$10.74 \times 2.50 = 26.83$
$26.83 \times 0.23 = 6.17$
$26.83 \times 0.77 = 20.66$

6.17	20.66	
0.05	0.02	
		44.25 cu. ft. O = 12.7%
6.22	20.68	280.1 cu. ft. N = 80.1%
2.52	13.55	25.11 cu. ft. CO_2 = 7.2%
		0.12 cu. ft. SO_2 =
3.70	280.1	
11.96		349.6
44.25		

Time	CO_2%	O%	CO%	
9:00 a. m.	9.90	9.15	0.00	Flue gas analysis made with Orsat apparatus by Capts. Hasbrouck and Fuller, Oct. 27, 1910.
10:05	12.18	5.67	.100	
11	11.80	6.05	.100	
12	12.75	4.66	.650	
1:00 p. m.	12.68	4.57	.507	
2	12.10	1.95	.504	
3	11.62	6.01	.502	
4	11.30	4.25	3.020	
5	14.00	4.00	.800	
5 second sample	13.35			
6	13.58	5.87	0.00	
7	14.32	3.48	.715	
Average	12.465	3.33	0.636	

Record of Boiler Test, Coast Artillery School,

October 27, 1910.

Time		Pressures						Temperatures							Wind	Weather
Hour	Min.	Boiler Gage	Barom.	Stack Ins. Water	Uptake Ins. Water	Furnace Ins. Water	Ash Pit Ins. Water	Room Air	Air to Ash Pit	Outside Air	Feed Water	Stack	Uptake	Furnace	Wind Velocity and Direct'n	Weather Rain Etc.
				0.02	0	—0.02	—0.02				8.0	<—Calibration Correct's				
8		115	30.23	.50	.38	.15	.03	98	98		66	460	620		S. W.	Clear
	15	109	30.24	.55	.45	.23	.05	108	108		66	475	660			
	30	109	30.25	.50	.42	.13	.08	98	98		65	485	655			
	45	113	30.24	.50	.30	.10	.02	94	94		65	490	630			
9		119	30.23	.40	.40	.22	.02	95	95		65	500	670			
	15	130	30.22	.53	.31	.18	.03	93	93	68	65	500	700			
	30	113	30.21	.50	.38	.22	.02	92	92	76	64	515	690			
	45	110	30.30	.47	.40	.21	.04	91	91	74	64	515	680			
10		124	30.20	.60	.43	.25	.03	91	91	74	64	525	700			
	15	118	30.20	.45	.40	.23	.02	92	92	79	64	525	705			
	30	120	30.20	.55	.39	.22	.04	94	94	*82	64	525	710			
	45	122	30.20	.55	.43	.23	.05	93	93	72	64	525	680			
11		125	30.20	.45	.33	.12	.02	94	94	74	64	525	665			
	15	123	30.18	.43	.32	.12	.02	94	94	84	64	475	580			
	30	127	30.18	.48	.29	.12	.02	95	95	82	63	500	630			
	45	136	30.16	.44	.38	.11	.02	95	95	84	64	500	650			
12		131	30.16	.48	.31	.12	.15	96	96	82	64	510	630			
	15	130	30.15	.45	.36	.15	.02	97	97	86	64	510	610			
	30	120	30.13	.50	.40	.13	.01	96	96	81	64	510	655			
	45	120	30.12	.43	.34	.15	.01	97	97	*92	64	525	640			

1		126	30.12	.48	.32	.11	.02	98	98	81	64	510	560			
	15	123	30.12	.53	.42	.15	.04	98	98	81	64	510	710			
	30	128	30.12	.43	.33	.18	.02	97	97	85	64	510	650			
	45	120	30.11	.40	.43	.30	.03	96	96	82	64	510	620			
2		120	30.10	.45	.40	.29	.02	97	97	84	64	490	630			
	15	111	30.11	.45	.42	.30	.01	100	100	81	64	505	650			
	30	100	30.10	.46	.24	.29	.02	102	102	78	64	500	645		S. W.	Clear
	45	80	30.10	.46	.40	.32	.02	100	100	78	64	455	575			
3		87	30.10	.42	.46	.40	.01	98	98	78	64	475	615			
	15	90	30.10	.44	.41	.39	.01	97	97	79	64	440	570			
	30	125	30.10	.42	.39	.28	.01	97	97	75	65	475	595			
	45	130	30.10	.42	.35	.27	.02	97	97	76	65	500	600			
4		111	30.10	.45	.34	.25	.02	97	97	78	64	475	580			
	15	132	30.10	.47	.32	.30	.02	98	98	75	64	500	645			
	30	131	30.10	.43	.34	.21	.01	98	98	74	64	510	650			
	45	124	30.10	.45	.35	.31	.01	99	99	76	64	510	650		S. W.	Cloudy
5		125	30.10	.45	.33	.25	.01	98	98	73	64	510	660		S. W.	Clear
	15	112	30.10	.43	.34	.26	.02	98	98	72	64	500	595			
	30	114	30.10	.45	.34	.24	.01	98	98	72	64	510	625			
	45	125	30.10	.51	.37	.24	.01	94	94	69	64	510	630			
6		123	30.09	.53	.32	.20	.02	94	94	70	62	520	660			
	15	106	30.07	.50	.37	.25	.00	93	93	70	62	500	625			
	30	113	30.06	.50	.37	.25	.00	93	93	70	62	490	620			
	45	119	30.06	.53	.32	.35	.00	93	93	70	62	495	610			
7		126	30.06	.50	.36	.28	.00	93	93	70	62	500	630			
	15	119	30.06	.47	.37	.26	.00	93	93	70	62	500	650			
	30	100	30.06	.45	.30	.27	.00	93	93	70	64	500	640			
	45	99	30.07	.43	.33	.24	.01	94	94	70	64	500	630			
8		92	30.07	.48	.31	.16	.02	94	94	70	64	500	605			

* Thermometer in Sun.

RECORD OF BOILER TEST, COAST ARTILLERY SCHOOL,

October 27, 1910.

Time.				Ellison Throttling Calorimeter			Throttling Calorimeter				
Hour.	Min.	Temp. Steam	Surrounding Air °F	Entering Steam °F	Cal. Temp. °F	Manometer Ins.	Entering Steam °F	Cal. Temp. °F	Manometer Ins.	Quality Steam	Per cent. Moisture
A. M. 8			118				347	275		98.7	
	15		119				344	274		98.8	
	30		120				344	280		99.1	
	45		122				346	278		98.9	
9			120				350	281		98.9	
	15		123				356	286		99.0	
	30		122				346	284		99.4	
	45		118				344	281		99.2	
10			122				352	282		98.9	
	15		124				349	281		99.0	
	30		127				350	284		99.2	
	45		124				351	284		99.2	
11			126				353	285		99.1	
	15		127				352	283		99.0	
	30		128				354	284		98.7	
	45		126				359	282		98.7	
12 P.M.			129				356	282		98.8	
	15		128				356	282		98.8	
	30		130				350	289		99.4	
	45		129				350	289		99.4	
1			130				354	286		99.6	
	15		135				352	288		99.3	

	30	132	355	288	99.7
	45	133	350	291	99.5
2		130	350	289	99.4
	15	131	345	288	99.5
	30	129	338	284	99.6
	45	127	324	277	99.7
3		127	329	268	99.0
	15	127	331	273	99.2
	30	127	353	266	98.0
	45	129	356	287	99.1
4		129	345	286	99.4
	15	131	357	285	98.9
	30	130	356	291	99.3
	45	132	352	292	99.5
5		132	353	292	99.5
	15	131	346	291	99.7
	30	130	347	284	99.2
	45	127	353	288	99.2
6		118	352	289	99.3
	15	111	342	276	99.0
	30	107	346	286	99.4
	45	106	350	287	99.3
7		107	354	281	98.8
	15	118	350	285	99.2
	30	125	338	284	99.6
	45	130	337	282	99.5
8		123	333	282	99.6
			Average 348.2	283.1	99.2

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Mimeograph No. 2 for Mechanical Specialists, Coast Artillery School.

Journal U. S. Artillery, November-December, 1909, January-February, 1910, March-April, 1910.

RECORD OF BOILER TEST, COAST ARTILLERY SCHOOL,

October 27, 1910.

Time		Coal Used				Manner Fired					Air Supply						Ash	
Hr.	Min.	Weighed Out	Weighed Back	Used Per Hour	Total Used	Quantity Fired	Door Fired	Fire Sliced	Fire Cleaned	Thick-ness	Ashpit Door 1	Ashpit Door 2	Ashpit Door 3	Cu. Ft. per Min.	Lbs. per Min.	Percent Moisture	Wet Lbs.	Dry Lbs.
8	00	1000					x		x	2	0	0	0					

RECORD OF BOILER TEST, COAST ARTILLERY SCHOOL,

October 27, 1910.

Time		WATER															
Hr.	Min.	Pump Tank Lbs.	Tank No. 1			Tank No. 2			Lbs. per Hour	Total Water Weighed	Temp. Water Weighed	Venturi Register	Kennicott Register	Pump Leakage Lbs.	Supply Tank Lbs.	Water in Gage Ins.
			'm'ty lbs.	Full lbs.	Net. lbs.	'm'ty lbs.	Full lbs.	Net lbs.					Apparent			
			182	960	778	168	959	791								
			185	949	764	170	949	779								
			183	964	781	175	938	763								
			173	954	781	189	948	759								
			176	953	777	183	953	770								
			189	961	772	179	950	771								
6	00	1022				459	955	496	9610	90303	70.7°	1,979,550	10.31			
			175	969	794	173	956	783								
			174	952	778	184	955	771								
			177	953	776	186	951	765								
			169	965	796	192	960	768								
			188	964	776	192	984	792								
7	00	830	176	974	798	569	966	397	9186	99489	70.7°	1,989,520	8.51			
			175	966	791	158	955	797								
			180	977	797	187	959	772								
			190	964	774	198	972	774								
			183	959	776	185	957	772								
			186	958	772	188	955	767								
8	00	900	180	970	790	521	943	422	8874	108363	71.6°	1,999,170		71		4.5

THE USE OF FIELD ARTILLERY

A lecture prepared for delivery to the Student Officers of the Coast Artillery School, 1912

By Captain OLIVER L. SPAULDING, Jr., Field Artillery

It is probably not necessary, before this audience, to speak at length about the materiel now in use by our Field Artillery. I will discuss it only briefly, for the benefit of any to whom it may not be familiar.

The gun used by light and horse batteries weighs, with breech mechanism, about 800 pounds; its caliber is 3 inches, and its length 29 calibers. It is of nickel steel, built up of a tube, jacket, locking hoop and front clip hoop. It has no trunnions, being mounted on a cradle by means of guides and clips formed on its under surface.

The breech mechanism is of the slotted screw, single-motion type. Two models are in use; with the earlier one, in case of a miss-fire, it is necessary partially to open and close the block before a second trial; the later model is "double action." It is arranged for percussion fire only; the firing pin is eccentrically placed, and can come in contact with the primer only when the block is fully closed. The piece may be fired either by a lanyard or by a trigger handle on the cradle; the latter engages only when the gun is fully "in battery."

The carriage consists of three principal parts:—the wheels, trail, etc., the rocker, and the cradle. The gun itself is mounted on the cradle, which permits it a motion in recoil of something over 40 inches. The cradle is pivoted on the rocker, upon which it has a traverse of 4 degrees on each side of the normal; and the rocker and cradle together are journalled on the axle, about which an elevation of 15 degrees and a depression of 5 degrees may be given.

The recoil is controlled by an oil cylinder lying inside the cradle. Return to battery is by helical springs assembled around the cylinder, and is regulated by an oil buffer. A fixed spade at the end of the trail holds the carriage in position.

The carriage is provided with a folding shield, proof against rifle fire at 100 yards. Under the cannoneers' seats on the axle are tubes carrying four rounds of ammunition, which are intended as an emergency reserve. The height of the axis of the piece above the ground is 41 inches. Gun, carriage, ammunition and equipment complete weigh 2500 pounds.

The limber chest opens at the rear, and contains 36 rounds of ammunition in individual compartments. The piece limbered, with full supply of ammunition and all equipment, weighs 4100 pounds, or about 685 pounds to the horse. With five cannoneers, the weight would be increased to about 800 pounds per horse. Without cannoneers and with empty limber chest, as used by horse batteries, the weight is reduced to a little under 600 pounds per horse.

The caisson uses the same limber as the piece. The caisson body carries one large chest, holding 70 rounds. The front of the chest is of the same plate as the gun shield; protection below is given by a plate which folds under the body when travelling, and above by the chest door, which is the rear wall of the chest and opens upward. Each caisson carries a mechanical fuze-setter.

The ammunition consists of common and high explosive shrapnel, and high explosive shell. If the high explosive shrapnel proves satisfactory, after more extended service experience, it may some time supersede both the other types.

The different projectiles differ slightly in length and form, but all have the same weight, 15 pounds. The propelling charge for shrapnel is about 24 ounces of nitro-cellulose, giving 1700 f.s. muzzle velocity with 33,000 pounds pressure. The charge for shell is slightly smaller, giving 1640 f.s. This makes the two projectiles range about alike; the elevations are identical for 2000 yards, and so nearly so for all ranges that the same sight scales may be used. All ammunition is fixed; the weight per round is about 19 pounds.

The common shrapnel has a base charge and a point combination fuze; it contains 250 half-inch lead balls. The remaining velocity at 6500 yards is 565 f.s.; the bursting charge adds 250 f.s. to this, making the bullets, at that range, effective 300 yards from the point of burst. The time train of the fuze burns 21 seconds, giving a maximum shrapnel range of 6500 yards. Fuze setting is effected by turning a disc about an axis coinciding with that of the projectile, thus changing the length of active train between vents.

The shell contains 13 ounces of Explosive D. A base detonating fuze is used, with copper and lead base cover.

The high explosive shrapnel is a so-called unit projectile, combining the characteristics of both shell and shrapnel. The main part of the projectile is like any other base charge shrapnel, but the matrix holding the balls in place is a high explosive. The front of the case is closed by a steel head containing another high explosive charge, and supporting the point combination fuze. If exploded in the air by the time element, the head is blown off, the body of the case acts like an ordinary shrapnel, and the matrix burns instead of detonating; the head continues along the trajectory and detonates on impact. If the time element is set at safety, or fails to act, the head detonates on impact, causing the sympathetic detonation of the matrix charge.

The instruments used in the service of the piece are the open and panoramic sights, the quadrant, and the fuze-setter. The scales of these instruments are graduated for range in yards, for angle measuring in mils. The mil is theoretically that angle whose natural tangent is 0.001, and hence is subtended by a chord of 1 yard at a radius of 1000 yards. This would give 6283 and a fraction in a complete circle; for convenience, the number is taken is 6400, and scales so graduated.

The sights are mounted on the left side of the piece. There is no special peculiarity in the open sights. The panorama sight is borne on the same sight shank; it is a prismatic telescope whose tube is twice bent at right angles, light entering at the objective being reflected downward and then horizontally again to the eye-piece. The hood at the objective end is capable of complete rotation, and a system of gearing moves the reflecting prism within the tube at exactly one half its rate, thus keeping the image erect no matter in what direction the hood points. The amount of rotation of the hood is measured by a limb graduated in 64 parts, and a micrometer dividing each of these into 100, thus reading to mils. Provision is made for illuminating the cross-hairs by an electric flash lamp, for night firing.

For direct fire, this sight is used in the same way as the open sights; for indirect fire, the horizontal angle between the target and any selected aiming point is given the gunner, who sets off the angle on his deflection scale and lays on the point.

The quadrant is mounted on the right side. It has a range scale graduated in yards, and an angle of site scale in

mils to correct for difference of level between gun and target. The two scales being set, the instrument mechanically combines the two angles into the proper quadrant elevation for the range and site, and the gun is laid for range by centering the quadrant level by means of the elevating gear.

The fuze-setter has two scales, range and corrector. If the range scale is set for any given range, and the corrector scale at 27, and a shrapnel is then introduced into the instrument and turned until the lugs of fuze and instrument engage and stop further motion, the fuze will be set for the whole time of flight corresponding to the range. If the corrector setting is higher, the time setting will be correspondingly shorter, and hence the burst higher in the air. At mid-ranges, each point on the corrector scale corresponds to one mil height; the usual height during fire for adjustment is one mil, during fire for effect three mils. With every thing functioning normally, this three mil burst is obtained by corrector 30; the arbitrary number 27 is added so that by no possibility can there ever be a negative corrector setting demanded.

The battery commander's telescope is used in connection with these instruments. This is merely a special form of transit, measuring both horizontal and vertical angles in mils. For quick measurement of angles the battery commander's ruler is used,—a brass scale which is held at a distance of 20 inches from the eye by means of a cord. The clear length of 6 inches on the scale is divided into 150 parts, so that when held perpendicularly to the cord the whole scale measures 300 mils, with a least reading of 2. For still more rapid and rough measurements, officers accustom themselves to use the hand, held at arm's length; held in the usual manner, its width is about 150 mils, but each officer individually calibrates his own hand and each finger.

Since artillery commands when in action are likely to be spread over a good deal of ground, and even battery commanders may find it necessary to take their stations at some distance from the guns, each command is provided with suitable signal equipment. The most important part of this is the telephone outfit; each battery has three instruments, with light wire and hand reels; each regiment and battalion two instruments, with heavier wire and a horse reel. The reel is constructed something like a limber without chest; in place of a caisson body it has a cart for carrying instruments. In addition to the ordinary battery instruments, regimental and battalion headquarters

are provided with a more complete signal outfit, a powerful tripod telescope for observing fire, and a mechanical plotting device for calculating deflections in indirect fire.

The gun whose characteristics and equipment have just been described is only one, although the predominant one, of a series of field guns and howitzers. All the others are more or less similar to it, so will not be described in detail.

The companion piece to the light gun, intended for curved fire, is the 3.8-inch howitzer, weighing nearly the same but carrying a thirty-pound projectile. The heavy gun is a 4.7-inch 60-pounder; the heavy howitzers are a 4.7-inch 60-pounder and a 6-inch 120-pounder. The howitzers have a variable length of recoil, the oil passages being automatically throttled as the elevation is increased. The mountain gun of the new series is not yet in service; it is to be a 3-inch 15-pounder, with long recoil and modern laying gear, designed for pack transportation.

In assigning these guns to mixed bodies of troops, the country where they are to operate will determine the types selected. If a division is to take part in an expedition through country where wheel transportation is difficult, it should be given the mountain guns; if in more ordinary country, light field guns. In the latter case, the 3-inch gun forms the bulk of the armament, but it is intended to give each division a few batteries of howitzers. These may be either 3.8-inch; if the latter, they will be given eight horses to a team, to make up the handicap of their greater weight. The auxiliary divisions of field armies are to be armed with 4.7-inch guns, 4.7-inch howitzers, and 6-inch howitzers; the 4.7-inch howitzers will have six-horse teams, the others eight-horse. Cavalry divisions will have horse batteries, armed with 3-inch guns, but to lighten the loads limber chests will habitually not be filled.

The 4.7-inch gun and the 6-inch howitzer are such weapons as would, a few years ago, have been classed as siege artillery. Of late, however, guns of this type have been discarded from the siege train in favor of more powerful ones. As an instance of the latest and most powerful siege armament, we may mention the Schneider 11-inch howitzer, which fires a 700 pound shell, but which, nevertheless, can be dismounted, packed on four carriages, and made ready for the road in one hour. At the same time, the mobility of the guns in question has been increased, and they are now able, without question, to keep their places with an army in the field.

A few notes on the actual performance of the 3-inch gun seem to be in order here. At 3000 yards, its probable error is 15 yards in range and 3 yards in direction. The angle at the apex of the shrapnel cone of distribution averages 15 degrees. As already stated, the height of burst in fire for adjustment is one mil, in fire for effect three mils; taking into account the errors of both gun and fuze, we may expect, when the average height is one mil, one or two bursts on graze out of every four-gun salvo, and when it is three mils, one graze in every two or three salvos. The individual shrapnel, bursting three mils high at mid ranges, distributes its bullets over a depth of about 200 yards and a width of 20.

All our field batteries, light, heavy and mountain, are organized on the four-gun basis. The details of organization vary in the different types, but that of the 3-inch battery may be taken as the general model. At war strength, this battery has twelve caissons; one is attached to each piece, forming four *gun sections;* the others form four *caisson sections.* These eight sections are grouped into four *platoons,* each under a lieutenant; the remaining vehicles of the battery constitute a ninth section, commanded by the quartermaster sergeant. When the battery forms for action, the first five sections constitute the *firing battery,* the remaining caissons and the forge and store wagons the *combat train,* and all transport wagons the *field train.* The chief of the third platoon, whose command is thus broken up, acts as *reconnaissance officer,* or general assistant to the battery commander. The first sergeant takes charge of posting the limbers; the chief of the fifth section, of the instruments at the battery commander's station. One corporal is assigned as *agent of communication* with the battalion commander; two corporals as scouts; and one corporal and two privates to handle the telephones and other signal equipment. All these details are permanent, and the men are trained as specialists.

When the firing battery is in action, one caisson is close beside each gun, and the remaining two close at hand, usually on the flanks. The most common methods of fire are battery or platoon salvos, volley fire, and continuous fire. In a salvo the pieces fire one shot each, in turn from one flank to the other, at three seconds interval; this fire is chiefly used in adjusting, and the interval is to enable the battery commander to observe each shot separately. In a volley, each piece fires a specified number of rounds independently of the others; special kinds of

volleys may be used, the elevation or deflection being changed from shot to shot. Continuous fire is the old fire by piece.

Field artillery materiel having changed so greatly in recent years, we naturally find great changes in the methods of handling it. These changes are not so much in principle as in detail; the prime object of artillery is, as it always has been, to assist the infantry, by firing upon whatever hostile troops are, at a given moment, most dangerous to it. But the new weapon is so much more powerful and flexible than the old one, that one should no more think of limiting it to the old tactics than to the old firing methods.

Tactics, broadly speaking, ought to be simply tactics, without any qualifying adjective. The terms "infantry tactics," "artillery tactics," may be looked upon as admissions of imperfection, or at least of incompleteness. The ideal is a system of tactics of the combined arms, in which each plays its part accurately; there should be no more thought of independence by infantry, cavalry or artillery than by the strings, brass and wood-wind of an orchestra, or the steam-valve, piston and connecting rod of an engine.

Failure of co-ordination is due to the imperfection of the instrument employed, taking the instrument to mean both machine and operator. Any improvement in the machine will soon bring about the necessary technical skill of the operator, and we may then look for better coordination with other machines of the system.

This is what is now happening as a result of the improvement in field artillery materiel. The personnel itself is gradually winning to a mastery of its weapons; the next step is adjustment to the needs of the infantry; then comes a corresponding modification of infantry methods to facilitate this adjustment; and the result is one more step from infantry and artillery tactics toward the tactics of the combined arms.

This readjustment of the reciprocal relations of the two arms is well reviewed in the following extract from an article published in the Italian *Rivista de Artigleria e Genio* for September, 1911.

"The adoption of the rapid fire field gun, besides causing considerable changes in the tactical handling of artillery, has had its effect also upon the use of the other arms, especially the infantry. This will be clearly seen from a comparison of the old and new tactical ideas.

"With the old guns, the artillery was expected first of all to engage the enemy's artillery with all possible force. The reason for this was found in the construction of the guns, which, not having any convenient means for

indirect fire, generally had to expose themselves. Hence it was possible, by a superiority of fire, to cripple the enemy's artillery; and, since this superiority of fire could be gained only by using a superior number of guns, every available battery was put into action as early as possible.

"The artillery duel, once begun, generally continued until one or the other party was annihilated, for the reason that, the batteries being unshielded, their only means of defense was to continue the fire. Therefore, when one side ceased firing, it could be assumed with little risk of error that it was out of action, at least for a considerable time.

"Hence the principle of massing guns for concentrated effect, with the definite intention of engaging the enemy's artillery, which was applied with such success by the Prussians in 1870-71, and which was accepted without question almost to the present day.

"During the artillery duel, the infantry advanced and engaged the hostile infantry. This action usually continued until the artillery of one side or the other, having disposed of its own adversary, came to the assistance of its sister arm with all its remaining force, concentrating its effort at that point where the resistance was weakest.

"The battle of Wörth may be taken as a typical example of this procedure. The Prussian artillery, massed on the plateau of Dieffenbach, engaged the French artillery, while the Prussian infantry, crossing the Sauer, became involved in an obstinate contest with the French infantry for the possession of Fröschwiller. No decisive success was obtained until the Prussian artillery, having silenced the French guns, was able to take a more direct part in the infantry action.

"The battle thus consisted of two separate engagements, fought with the same object in view, and coming into close connection at the end, but developed independently of each other. Thus, in the course of time, an exaggerated importance came to be attributed to the artillery duel, so that ultimately the action of the one arm was subordinated to that of the other, and it was held that the advance of the infantry could not begin until the artillery duel was decided.

"The adoption of the new armament caused radical changes in these theories. The characteristics of the new materiel which most strongly influenced military students were the improved protection of personnel and materiel, and the great increase in rapidity of fire.

"The increased protection, due not only to the shields, but also to the new methods of laying, which facilitated the use of covered positions, has greatly reduced the effectiveness, and hence the importance, of the artillery duel. The enemy's guns can no longer be permanently silenced by artillery fire alone. Even if definitely located in its covered position, artillery can always shelter its personnel behind the shields, while volleys are being directed upon it, ceasing fire for the moment but resuming it at the first opportunity. Being unable to get immediately decisive results in the old way, the artillery has had to find new ones. Its first and principal objective can no longer be taken, *a priori*, to be the hostile guns, but from first to last it must fire upon whatever target it can attack most effectively. What that target is at any particular moment must be determined by the progress of the infantry action, and by the information received from it.

"Extremely rapid fire being possible, effort should be made to utilize this power to the full, taking care, however, not to waste ammunition.

Hence the fire, as a rule, can not be continuous, but must be in short violent spurts, coming irregularly and unexpectedly. Hence silent guns are not necessarily silenced guns; their silence is the calm before the storm; their volleys are thunderbolts.

"All this demonstrates the necessity of active and constant observation of the battlefield, and also of proportioning the number of batteries sent into action to the importance of the immediate target, instead of throwing them all in at once.

"The infantry, for its part, has recognized that the artillery alone can no longer silence the enemy's guns, and needs the help of its sister arm. The infantry can no longer wait for the artillery to prepare the way for its advance; it must move on, cautiously and slowly of course, but promptly; thus it can force the enemy to reveal his position, and expose himself to the combined fire of infantry and artillery. The work of the infantry is consequently harder than ever. It must be better prepared than ever, both morally and technically, to face the destructive and nerve-racking fire of artillery; it will be the principal target, and will have no notice of the presence of artillery except the bursting of the shrapnel.

"But this is only one side of the question. As the infantry advances, there will come a time when it has to face the effective fire of both infantry and artillery; and then it will need the help of its own artillery if it is to get on. It is now necessary for the artillery to regulate its action according to the needs of the infantry, drawing upon itself the fire of the enemy, or beating down that part of the hostile force which is doing the most damage to the infantry.

"Infantry and artillery fire should supplement each other; the two arms must constantly work together, seeking to gain superiority of fire as the *sine qua non* of success. Instead of acting along parallel lines the two must now act together. Tactically each arm supplements the other, so that the action of each is the condition precedent for that of the other; hence a system of constant communication between them is absolutely mecessary."

The purpose of an army is to win battles. In the process, the infantry plays the predominant part; each of the other arms owes it certain assistance, and, conversely, has the right to expect certain assistance from it. Let us see how, in a general way, this works out practically as affects the artillery.

A great battle will necessarily be made up of countless minor episodes, partial engagements; first one side will be successful, then the other. But in general we may say that all these minor affairs merely lead up to, accompany, or follow, some one critical phase, which consists of a decisive attack by one party upon some position, more or less prepared, held by the other. Hence we can get a pretty good idea how things should or must be done, if we follow the course of one such attack and defense.

We may imagine a force on the defensive, and another attacking it. For our purposes it is immaterial how or why the defensive attitude was assumed,—whether voluntarily and

deliberately, or under constraint and hurriedly. But the force is there, and has made such preparation for defense as time and circumstances permit. A particular position, we will say, has been entrusted to a division, using that term as we understand it in our service.

The general defensive line being determined, the question is how to occupy it. Since infantry can not act at such great distances as artillery, it usually receives the first consideration, and the artillery is made to conform to its needs. In special cases, however, the condition is reversed; for instance, on a given front, there may be only one suitable position accessible to the artillery, and the infantry, being able to move and fight on more difficult ground, is required to give way.

The position probably falls, more or less naturally, into several sections. Each of these receives certain troops, whose commander is given such degree of independence as the case requires. To some of these commands artillery will be permanently assigned; but care will be taken not to detach more batteries than necessary from the main artillery command. If they remain under the control of their own brigadier, they are available for use anywhere; if they are assigned to some one else, it may be harder to get them back quickly when wanted.

This preliminary distribution leaves the division commander considerable forces, both of infantry and artillery, at his own disposition. Some small parts of these may very likely be used in front of the line, in connection with cavalry, to develop the enemy's force and line of advance, and to delay him. But the bulk of them are held back, to be thrown into the main fight whenever and wherever they are needed.

The artillery, as well as the infantry, may in some sense be said to constitute a reserve; but there is a radical difference in the methods of handling them. The infantry is intended to be held as long as possible, and sent in only as the final argument; the artillery is intended to be used as soon as possible, and is held back at the start only because, in the nature of things, the defender has to play to the attacker's lead. The reason for this difference is, that when infantry is once sent into action it is almost impossible to change its objective, or use it for any other than the original purpose; artillery, with its present long range and indirect firing methods, can often be kept in action indefinitely, changing target at will over a wide front.

Some of the guns assigned to the subordinate commanders

may very likely be put in permanently, in entrenchments, at selected points of the defensive line. But a mobile gun is worth much more than an immobile one, so the majority of them will be placed "in observation"; that is, they will be unlimbered in a covered position and given a particular area to watch. Complete firing data will be prepared for conspicuous landmarks, and each battery will hold itself in readiness to fire at a moment's notice upon any target appearing within its area.

Part of the guns remaining in the hands of the artillery brigadier will also go into observation positions; the rest will be held "in readiness," limbered, to be sent into action as soon as the direction of the attack can be determined. For these batteries, several positions will be reconnoitered and prepared, so that they can occupy any one without delay or confusion.

On the part of the attacker, there will necessarily be a gradual and tentative advance. His advance guard, which in a large force will of course contain artillery, will at first suffice to push back any small detachments that it may encounter. As he comes nearer, he may find detachments that seem strong in artillery; he can not tell at once whether these intend real resistance or mere delay, so he may be compelled to slow down, and bring up help from the main body. But after a time it will become apparent that he is opposed by the enemy's whole force, and he will have to prepare for a general engagement.

In making dispositions for the attack, the same principle holds,—that batteries should be detached from the artillery command, and assigned to local forces, only if the desired result can not be obtained otherwise. But since the attacker makes his own law, instead of taking it from his enemy, he can arrange for more intimate connection between the two arms than the defender.

The defense is not likely to be drawn into an artillery duel of the old classic type. In all probability it will hold its artillery fire as long as possible, to keep the attack in doubt as to the position. But the advance of the attacking infantry will draw fire, and the artillery of the attack must be ready to help.

During the preliminary stage, the dispositions may somewhat resemble those of the defense. A few guns will be put into action, but a large force will be kept in observation or in readiness, so as to take no unnecessary chances of even a temporary inferiority. An artillery duel will result, but as an

incident to the advance of the infantry, not as a decisive phase of the battle.

As the information of the commanding general becomes more complete, his plan of attack will form itself. His separate columns will begin to move out against their individual objectives. In some cases, batteries will be definitely assigned to these columns; but preferably they will remain under the orders of the higher artillery commanders, and be assigned simply to support particular columns. Their general positions and objectives will be given them, and they will be ordered to fire upon such particular targets as may be designated by the commander of the column. This evidently necessitates a system of direct communication between the attacking infantry and the supporting artillery; and the best method of establishing and working this communication is one of the live military questions of the day.

This may look very much like attaching the batteries to the attacking columns; and it is, to a certain extent, a placing of them under the orders of the column commanders. But it does not definitely remove them from the direct control of the higher artillery commander; he is always in touch with them, knows where they are and what they are doing, and can change their targets or modify their distribution at will. This makes the whole scheme more coherent and flexible.

In the course of the attack, the batteries will naturally fall into groups. Part of them will be assigned to keep down the fire of the opposing guns; and to do this each such battalion and each such battery will be assigned its own part of the enemy's front to observe. The rest will directly support the infantry, firing upon the trenches at the point of attack until the infantry has come to close quarters, and then, when the fire endangers their own friends, lengthening the range and firing upon the ground over which the enemy's supporting troops must come up. These batteries may have to change position several times, and some of them will keep as close to the infantry as possible, so as to be able, in case of success, to help hold the captured position; but changes of position are always bad, and when a battery has once gotten its fire adjusted it should stay in place as long as it can do its work.

We now have an outline of the work expected of the artillery, and a summary description of the tools it works with. The question which, I imagine, most interests this audience is, how the tools are used to accomplish the tactical purpose.

In general, we may say that a division commander, having received his orders and formed his general plan, will consult with his artillery brigadier, whose proper place is at division headquarters, as to the best use of the guns. This being settled, the brigadier will order the necessary detachments, and divide the work between the regiments. Regimental commanders, in their turn, apportion the work to their battalions; or, in exceptional cases, where the regiment can come into action as a unit, they may actually conduct the fire. Battalion commanders frequently conduct the fire of their battalions; but fully as often they only direct it,—that is, apply it tactically and supervise it,—leaving the actual conduct to the battery commanders. That is, the higher the rank of the commander, the more he has to deal with tactics, and the less with technique. Here is one of the reasons for avoiding detachments, and dealing in as large units as possible,—if the subordinate has to think too much of tactics his technique will suffer.

To bring our ideas down to the earth, let us take a concrete case. We will imagine a division on the march, with one battalion of artillery in the advance guard, and the other battalion of the same regiment behind the leading infantry regiment of the main body. The advance guard encounters opposition, and becomes engaged; reinforcements are called for from the main body. The colonel of the leading artillery regiment is ordered to bring up his other battalion.

Telling the major to get his battalion clear of the infantry column and then rejoin him, the colonel, with his staff and scouts, gallops ahead to find the advance guard commander. His chief of scouts posts men where necessary to mark his route so that the major may follow. He learns that his first battalion has gone into action on the left of the road which forms the main line of march, to support the advance of the infantry upon a ridge in front which is held by the enemy; but that hostile artillery has opened fire, two batteries have had to change target to reply to it, and the single battery remaining is not enough to keep down the enemy's infantry's fire. He is directed to get his other battalion into position on the right of the road, silence the enemy's guns, and support the attack which is about to be made by the whole leading infantry brigade.

Meanwhile the major commanding the second battalion has succeeded in clearing the infantry, and has come up to

join the colonel, leaving orders for his senior captain to bring on the battalion after him. As he goes, his chief of scouts relieves the regimental scouts posted to mark the road, substituting his own men. Having reported to the colonel, he is shown the general position for his battalion, and the enemy's guns are assigned him for a target.

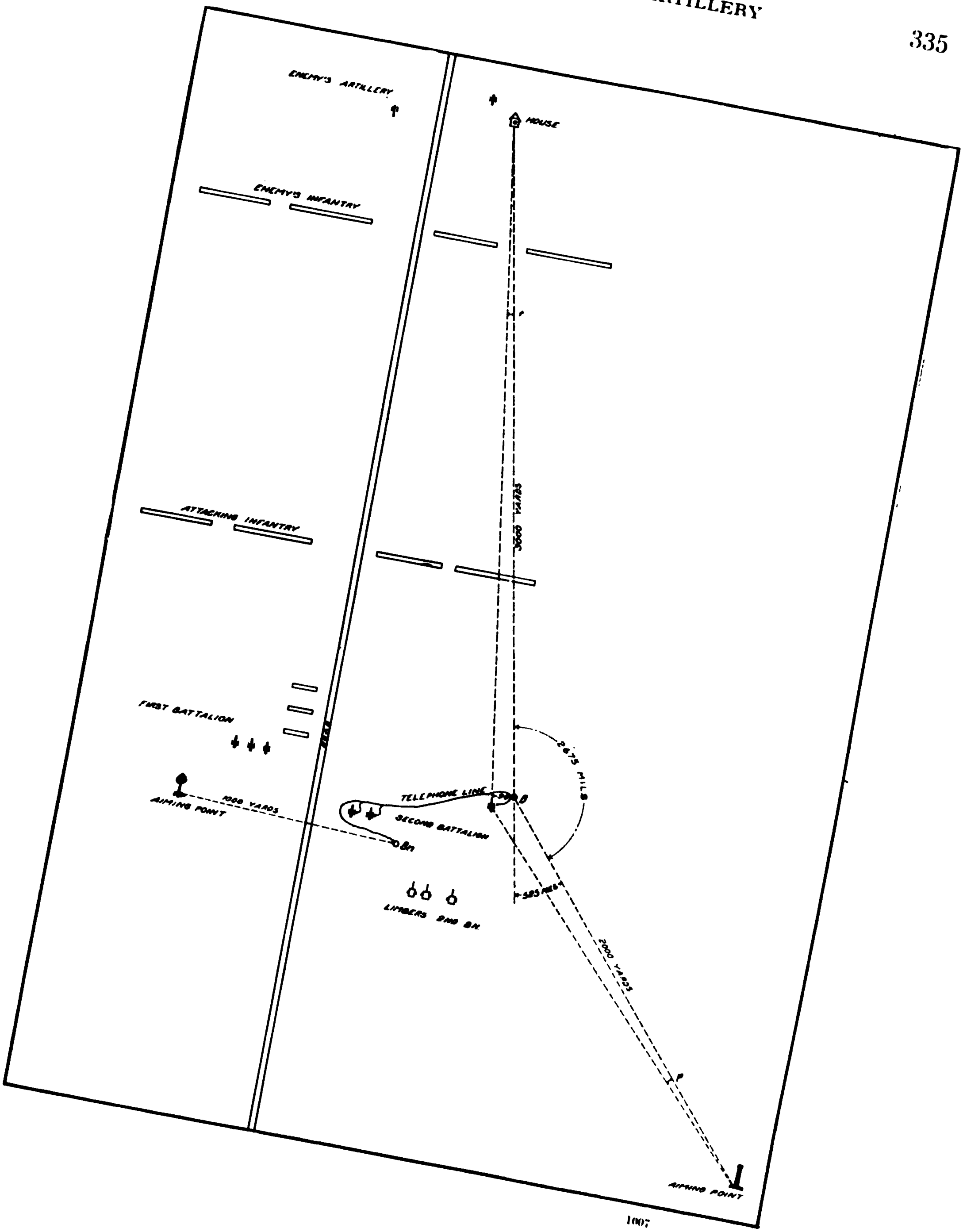
If a regimental telephone line is to be used, the regimental adjutant and sergeant major, with the regimental signal detail and reel cart, now lay it out. In a case like this, however, this will probably not be needed; the position will probably not be retained very long, and the colonel can better send what few orders he has to give by couriers.

Having seen the work of the second battalion under way, he rides over to the first battalion and explains the new arrangement to its commander. He directs him to continue his fire until the second battalion opens; then to turn his whole battalion upon the enemy's infantry.

The commander of the second battalion sends back for his battery commanders, and commences to reconnoitre his position. He finds that two batteries can be placed together near the road, well concealed from the enemy's artillery positions. The guns will be in a broad open field, masked by high woods some distance in front; the only observation station is on a hill to their right rear. A tall lone tree a thousand yards to the left makes a good aiming point. There being no room for the third battery here, the major decides to conduct the fire of the two batteries personally, and send the third to a little hill a short distance to the right front. He indicates all this to his adjutant, and directs him to establish communications and open an observation station; he himself meets his captains and gives them their orders.

Since two batteries are to be handled as one, by the major himself, their captains have nothing to do, prior to the arrival of their batteries, but to mark the exact positions of their right and left guns, and send scouts to reconnoiter a road to the place designated by the major for their limbers.

The captain of the third battery gallops out to the position assigned him. He finds a satisfactory position for the guns on the rear slope of his hill; but since it has a little less than mounted defilade against the probable positions of the enemy's observers, he notes that he will have to dismount the battery a little before he reaches it. There is a good observing station about 100 yards to the right and a little in front, and good


ENEMY'S ARTILLERY
HOUSE
ENEMY'S INFANTRY
ATTACKING INFANTRY
3000 YARDS
FIRST BATTALION
2675 MILS
AIMING POINT
1000 YARDS
TELEPHONE LINE
B
SECOND BATTALION
Bn
325 MILS
LIMBERS 2ND BN.
2000 YARDS
AIMING POINT

1007

cover for the limbers 300 or 400 yards to the left rear. He selects a factory chimney about a mile away, to the right rear, as an aiming point. He posts his trumpeters on foot to mark the places for the right and left guns, and sends his reconnaissance officer, with the chief of the fifth section, to the observation station to commence work.

But as he looks back toward the road, and notices the infantry massing there, he suddenly feels lonely. True, there is a whole regiment out in front of him, and strong reserves close at hand; but he is pretty well out to a flank, and the country is not all open. It occurs to him that a venturesome squadron of cavalry might get around that flank somewhere, and make it very unpleasant for him before he could get help; so he sends his scouts out that way to give him timely warning of any such danger, and makes a mental note that it would be well to ask the major, at the earliest opportunity, to send a few more.

By this time the battalion has come up and is waiting, the lieutenants in command having led the battalion by the best routes they could find to the vicinity of the positions they saw their captains reconnoitering. The captains meet them, and personally lead them in.

While all this is going on, the instrument cart has been driven as near the battalion station as possible, and there unlimbered. The battalion sergeant major, with the signal detail and reel limber, has laid a wire from the station, across the front of the first two batteries, and on to the observation station of the third. In doing this, he has avoided, as far as possible, laying wire where carriages or limbers will have to move; where it is evident that they must pass, he has prepared crossings by elevating or burying the wire, and has cautioned the line guards to point out these places. All batteries connect their own telephones to the battalion wire, by short lengths of buzzer wire. This line is entirely independent of the one that the third battery has established, with buzzer wire and hand reels, from the captain's station to the guns.

The reconnaissance officer of the third battery has the telescope set up at the station designated to him, placing it in a patch of brush where it is well concealed. Not knowing precisely what the battery's target will be, he picks out a farm house near which he has seen the flashes of hostile guns, and prepares firing data for it.

Measuring the horizontal angle from the aiming point to

this house, he finds it to be 2675 mils. He estimates the range to the house at 3000 yards, and to the aiming point at 2000. The angle of site of the house measures 303; since the observation station is some ten feet above the level of the guns, he calls it 304. The perpendicular distance to the line of fire of the right piece is paced by the chief of the 5th Section, and found to be 94 yards.

He is now ready to compute his firing data. To do this he employs the formula (which is readily demonstrable geometrically)

$$D = a + n\,(p - t)$$

in which

D = the required deflection for the right gun,
a = the measured azimuth 2675,
n = the distance from the station to the line of fire of the right gun, expressed in platoon fronts of 20 yards,
p and t = respectively the angles at the aiming point and the target, subtended by one platoon front at the battery.

The quantities in the second member of the equation are all known except p and t; these must be computed. Since the range to the target is 3000 yards, the linear value of a mil there is 3 yards; the angle t, then, is 20/3, or 7 mils, which is called the *parallax* of the target. In the same way, we find that the normal parallax of the aiming point is 20/2, or 10 mils; but since the aiming point is not on a line normal to the battery front, but 525 mils from the normal, as the measured angle shows, the parallax is not actually so large. It should be corrected, as will be readily seen by referring to a diagram, by multiplying it by the natural cosine of 525 mils. Since great accuracy is not necessary, parallaxes with only slight obliquity are usually used uncorrected; it is desirable to correct this one, however. Now the natural cosines of 400, 800 and 1200 mils are .9,. 7 and .4; multiplying by .9, the nearest value in this case, the corrected parallax is found to be 9. The equation then becomes

$$D = 2675 + 5(-9 - 7) = 2675 - 80 = 2595$$

The algebraic signs are governed by the convention, that measuring from the directing gun, *front* and *right* are positive, *left* and *rear* negative.

The deflection for the directing gun is now known, but not that for any other gun. In the absence of reason to the con-

trary it is customary to start with the guns parallel, or perhaps slightly diverging, and modify the distribution afterward as circumstances require. As may readily be demonstrated, parallelism requires the deflections to form an arithmetical progression whose common difference is equal to the parallax of the aiming point. Here, then, the deflection difference will be —9, or, approximately and conveniently, —10.

While the reconnaissance officer is finishing this work, the captain comes to the observation station, having put the battery in position, sent off the limbers under command of the first sergeant, and given the gunners their aiming point. He inquires whether both telephone lines are in operation; finding that they are, he glances at the reconnaissance officer's figures, verifying and completing them, and then sends to the battery:

"Deflection 2595; diminish by 10; angle of site 304; corrector 28-inches."

He makes no mention of range. In the first place, the laying is not on a target, but only on a point near which targets may be expected; in the second, announcement of the range is always the signal for setting fuzes and loading, so range is never given until ready to fire.

A message is soon received from the major, directing the captain to observe a certain sector, bordered by clearly defined landmarks, and fire upon any hostile artillery that he may discover there. Measuring with his rule, the captain finds a clump of trees on the sky line, near the middle of his sector, to be 95 mils to the left of the house upon which his guns are laid, and telephones to the battery, "Add 95." Thinking that a better view of the ground may perhaps be obtained from farther to the right, he sends his reconnaissance officer, with a signal man, and a trumpeter to hold the horses, out that way to find an observing station in a tree or house, and signal to him the fall of his shots.

Soon after, the flashes of hostile guns are seen behind a little ridge, 20 mils to the right of the trees and a little lower. The captain commands:—

"By battery from the right; substract 20; angle of site 303; range 2600."

He adjusts his fire on the crest, and then increases his range until, from the appearance of the ground and from the reports of his reconnaissance officer, he believes he has passed beyond the target; he then continues firing volleys, closing in his bracket as much as the facility of observation will permit.

If the reconnaissance officer can get to a place from which he can see the target clearly, he might even pass to shell fire for demolition.

The major's handling of the rest of the battalion would be very much the same. He would treat it as one large battery, and the captains would act as a superior variety of chiefs of platoon. In computing firing data, however, he would have a mechanical plotter at his disposal, which gives greater simplicity and accuracy when the observation station and aiming point are inconveniently placed with reference to the guns; and for observing fire he would have a powerful telescope.

It has been suggested to me that I make specific application of the tactical principles here mentioned to the requirements of Coast Artillery supports. It seems to me that very little need be said on this subject; the work in hand is not in a class by itself, but is merely a particular case of defensive action by infantry and field artillery. The dispositions are simplified in that only passive defense is called for, but the artillery work is hampered in that most of the materiel is of old types, and is deficient in mobility.

Looking at the subject broadly, it would seem that the conditions simply impose exceptional care in reconnaissance and preparation of positions; and since the work can be done in time of peace this is no disadvantage. The guns being deficient in mobility, the greater part of them must be put in position at the outset; that is, a large proportion will be *in observation*, and very few *in readiness*. If the defensive position be exhaustively reconnoitered, those positions can be selected which best combine good protection with broad field of fire; suitable shelters and masks can be planned; and the sectors of observation of the various guns or batteries can be laid off so that all dangerous places are covered and the guns can mutually support each other.

The disadvantage that many of the guns are of old types may be minimized by timely preparations. Indirect laying with them is perfectly practicable, given plenty of time to prepare the position and set stakes to mark lines of fire. The guns will recoil on the ground, of course, but expedients to minimize recoil and facilitate running up will readily occur to any officer laying out the positions.

Courtesy of American Press Association. 100K

U. S. S. Florida
Bow View

Courtesy of American Press Association. 1009

U. S. S. FLORIDA
Stern View

PROFESSIONAL NOTES

THE PROPER CALIBER FOR THE HIGH-POWER GUNS OF SEACOAST BATTERIES*

By Captain EDOARDO DE VONDERWEID, Italian Artillery

Translated from the Italian by Captain George A. Taylor, C. A. C., for the Journal U. S. Artillery

(Concluded)

The theory is advanced that 240 mm. (9.45-inch) guns are quite sufficient for all work at the shorter ranges, since it is found in the perforation tables that, for example, a 240 mm. (9.45-inch) 50-caliber Krupp gun with a projectile weighing 190 kilograms (418 lbs.), and employing a velocity of 939 meters (3080 f.s.) is capable of penetrating 390 mm. (15.35 inches) of K.C. armor at 5000 meters (5468 yards). However, supposing that the vessel under fire is on such a course that she presents only an oblique target to the battery, how much margin does the foregoing leave for the penetration of a heavy plate? However, these advocates do not consider short-range action as of only exceptional occurrence, and do not admit that, only through grave necessity, would an attacking fleet dare to engage the batteries at close range.

When a hostile ship is approaching a battery, the proposition presented is to silence the guns of the vessel as quickly as possible, attaining this end with a minimum number of shots; it is evident that the greater the smashing effect of the shots fired, the quicker is the result desired accomplished, and the greater the caliber and charges of the guns, the greater is the damage done.

The high rate of fire of minor caliber guns does not offset the greater power of the larger caliber guns, since, unless some unforeseen obstacle arises, it stands to reason that a coast battery can bring to bear such a volume of fire as to assure the gunners being able to bring the center of impact of the shots upon the target.

Even if they pass over the comparison of the probability of fire of the two types of gun, they should not disregard the part that the range plays, for at long range the number of hits with the smaller caliber guns will be greatly reduced, and in all probability, shot for shot, they will not make as many hits as the larger guns, whose rate of fire is not so rapid. The fact that a ship going at the rate of 20 knots per hour passes over 10 meters in one second, (11 yards per second), shows conclusively that it is possible to correct the fire for "overs" moic accurately, if the lateral errors are measured by only a few yards, according to the lateral component of the movement of the vessels parallel to the battery, but this is a more difficult problem, when the course of the ship is somewhat oblique to the line of fire.

* Continued from JOURNAL U. S. ARTILLERY, March-April, 1912.

However, admitting that the fire of 240 mm. (9.45-inch) guns is easily controlled at short ranges, must it not be acknowledged that the fire of this gun at long ranges is ineffective? The way that this question appears to us is that the advocates of small-caliber guns are endeavoring to establish, in a theoretical way, the fact that the practical view of the question may be disregarded. They say that, when an action is actually taking place, it would be very inadvisable to neglect to use all the guns at our disposal, for only by the employment of every available gun could we expect to produce a maximum volume of fire in a minimum amount of time. A potent argument in substantiation of my views upon this subject, which, by the way, is very opportune, is the fact that, since the first really large modern naval battle, all the naval powers have been hastening to arm their warships with high-power guns of single caliber.

Why should coast batteries at the opening of an action have a greater need than the attacking fleet of asserting a superiority of fire, in order if possible to silence their guns? This result will be possible only in the cases of fortified harbors, which have an abundance of all kinds of batteries; but only the wealthier nations will be able to maintain such expensive armaments. On the other hand, generally speaking, if all the batteries are brought into action, will the total fire effect be adequate to the task of repulsing the fleet?

In the last analysis, the installation of guns is only one of the means of strengthening and defending a position, and the defensive works of certain harbors will necessarily be more extensive than in cases where it is possible to meet the situation with guns of smaller caliber.

Today all coast artillerymen are agreed as to the importance of rapidity of fire, which is indeed a most weighty factor. Although technical improvements have made possible a degree of speed, which a few years ago would have been regarded as visionary, it will be folly to stop progressing towards the maximum limit of perfection possible, especially since the greater the masses of the projectiles, with which it is possible to batter the target, within the limited space of time which it remains within the field of fire of the battery, the greater is the possibility of obtaining a positive result—that is to say, the complete destruction of the attacking vessel.

It is axiomatic that there is a certain advantage in maintaining a great volume of fire; however, ammunition should not be needlessly expended, that is beyond the limits of any possibility of obtaining commensurate results.

It is not possible to reduce this somewhat abstruse question to concrete terms, but it is generally recognized that the errors to be expected are due partly to instruments, and partly to certain factors of which the following may be enumerated:—

a. The personal equation of the observer of the splashes.
b. The accuracy of fire of the guns.
c. How closely the corrections made approximate the true corrections.
d. The dimensions of the total rectangle.

We may easily conceive that the perfect result to be obtained is when the rate at which the guns may be fired is limited only by the speed and facility with which their loading may be accomplished, and we must admit that here the smaller caliber guns do have an advantage.

There are certain advantages, which we have not yet mentioned, which do not appear at first sight, and which are attributable to an increase in caliber:—

(1) Small variations in the weight of powder or projectile are of so much less consequence, since the total weight of each is relatively so much greater.

(2) The variations in the atmospheric conditions have less influence, because the ballistic coefficient is so much greater.

(3) The danger space increases as the angle of fall decreases, and decreases with a corresponding diminution in the value of the ballistic coefficient.

Consequently, if I should admit that "hits per gun per minute" should be the one end to be desired, and that we should accordingly employ small caliber guns, I believe that, if I were not reasoning against the truth of the matter, I would not be very far from so doing. The lessons derived from the Russo-Japanese War uphold my ideas upon the subject, but in some ways this war was not wholly satisfactory, that is to say, as a precedent for future wars; I myself believe that we have attained a certain advantage as to rapidity of fire, by our training in times of peace, which is second only to that of the United States, which may be expressed in tabular form as follows:—

.72 "hits per gun per minute" for a 12″ gun.
.76 "hits per gun per minute" for a 10″ gun.
1.83 "hits per gun per minute" for a 8″ gun.
4.00 "hits per gun per minute" for a 6″ gun.

The last two guns are capable of shooting at very much shorter ranges than the first two, and I will leave them of out the consideration. If we assume that the rapidity of fire of the first two guns is as 3 is to 2, the proportion of hits is far from being in like ratio, for the 10-inch gun should have proportionally 1.08 "hits per gun per minute," as compared to .72 for a 12-inch gun.

[*Translator's Note.*—The author handles these figures by proportion, that is, 1.08 : .72 : : 3 : 2, a very simple analogy, which nevertheless may not appear to the reader at the first glance.]

If we consider the question in the abstract and compare the 12-inch and 6-inch guns, which have a ratio of fire of about 1 to 6, a comparison of the results obtained by the fire of the two guns will not give the 6-inch gun the advantage, which one might be led to expect.

If, through an excessive desire to avoid doing any injustice, I may possibly be willing to admit, contrary to my better judgment, that the number of hits is directly proportional to the respective rates of fire of the various calibers, I must, however, adhere to the opinion that, if the smaller caliber guns are chosen for adoption, the destructive effect upon the target will be less than for the larger guns, although with the decrease of caliber the percentage of hits has been increased.

Unfortunately there are no concrete precedents on the subject, by which we may be guided, so that it is necessary to consider the question from an abstract point of view. However, this method should be convincing, since it must be acknowledged that the destructive effect of the projectile upon the plate increases greatly with the increase in caliber, and conversely. It suffices to consider how the residual force of the projectile is greater as the remaining velocity is greater, and that, other things being equal, we should employ a type of projectile, the ballistic coefficient of which is necessarily large, by reason of the great mass of the projectile, which, incidentally, increases as the cube of the caliber. Likewise the weight of the powder charge increases approximately as the cube of the caliber. There are those

who believe that the speed of fire of the smaller guns makes up for their insufficiency of smashing power, on the assumption that the rapidity of fire varies inversely as the cube of the caliber.

In conclusion, the reduction of the present caliber of our guns is not, as some would pretend, justifiable.

The latest argument in favor of the reduced caliber theory is that for every additional inch in the caliber of the gun the life of the gun is reduced a corresponding amount, until the number of shots which the gun will stand is reduced so much that a coast battery equipped with such guns would be greatly handicapped.

In the 1906 report of the Chief of Ordnance to the Secretary of War of the United States, he makes the statement that 12-inch, 40-caliber guns, (weight of projectile 1046 lbs. and initial velocity 2500 f.s.) have been known to become useless after only 60 shots, and that this is not a mere impression, but a fact. However, can we regard this as the last word as to the question of the life of modern guns?

It is well to assume that this subject is still in its infancy, since, although many theories have been advanced, the question narrows down to that of the limit of perfection in the manufacture of guns, to which it is possible for us to attain, and this naturally depends upon the type of gun-steel which will be produced in the future.

Without going into the highly technical aspect of the question, I believe that I can draw the attention of the reader to a few of the more important points in regard to the life of guns, considering the subject from the point of view of the relative size of caliber.

We will first note that the normal causes of the deterioration of guns are as follows:—

a. The excessive and progressive enlargement of the bore causes an appreciable variation in the amount of travel of the projectile, varies the density of loading and the initial velocity, and consequently materially affects the accuracy of fire.

[*Translator's Note.*—The author evidently refers particularly to the erosive effect upon the inclined portion of the lands of the forcing cone.]

b. The eating away of the metal due to erosion, which is more or less appreciable throughout the bore, is especially manifested in the first portion of the tube.

In order to offset and correct this defect, the expedient of using a rotating band of more than normal width is resorted to.

However, this is but an expedient, which may be efficacious in particular cases, but cannot be universally so, for the amount of erosion along the bore is an exceedingly variable factor, and cannot but alter the phenomena of interior ballistics, which take place within the gun, and thus cause a variation in the initial velocity and a corresponding reduction in the precision of fire of the gun in question.

It is my modest opinion that the matter would be greatly improved, if the elastic expansion of the walls of the piece at the moment of firing was reduced to a minimum. If, as perhaps I should, I am willing to admit that by no known device of science can the elastic limit of the material employed be increased beyond a certain point, even by the use of other substances in combination, (just as it was in the case of the old compressed bronze guns), we must not abandon the principle that the maximum pressure must be kept

as low as possible, coupled with a suitable increase in the thickness of the walls of the tube of the gun.

The larger caliber guns today present the serious defect that their tubes are appreciably enlarged in diameter after possibly only a few shots, which fact might appear very inimical to all my good arguments.

As to the causes which produce this deterioration of modern guns, I will not take the time of the reader by entering into any exposition of the theories which have been evolved, and which are more or less unproven and not very dependable.

However, I will not omit to state here that the reason for this phenomenon has been ascribed to the high temperature of modern explosives. However, the fact remains that in the United States Artillery, which employs exclusively, as for example in their 12-inch guns, powder having a nitrocellulose base, the amount of erosion does not appear to be very greatly reduced. I will endeavor to show elsewhere that erosion may possibly be very largely attributable to the cutting effect of the hot gases under high pressure, which escape past the rotating band. Whatever I might have to say, in my poor way, as to the causes of erosion would have no weight; however, from a perusal of that which others have written upon the subject, it would seem that the true cause might be as I have indicated. We are principally interested, however, in the question of the proper caliber of guns for coast batteries, and will not attempt to decide as to whether the increase of pressure of the powder gases, or some other important factor is the real cause to which erosion may be attributed; it must be admitted that, whether the caliber is increased or decreased, the fact that the maximum pressure is so well nigh uselessly great at the moment of discharge, and then falls off so rapidly is a grave defect, and tends to reduce too greatly the length of usefulness of our high-power guns. This defect makes it necessary that a certain proportional number of guns be held in reserve. In England the reserve is about 24%, but in other countries not so rich, such a proportion can hardly be afforded.

However, can we assume that a reduction in the caliber of our guns will necessarily assure us that they will possess great durability? We may admit that the smaller the gun the less quickly does it deteriorate, but in reply to this it may be said that, although the number of shots per minute is greater, many of the shots do not hit the target, and certainly not enough to compensate for their lack of power.

Referring again to the 1906 Report of the Chief of Ordnance to the Secretary of War of the United States, we find the statement that a 12-inch gun may be regarded as having lost its accuracy of fire after 60 shots, and a 6-inch gun after 150 shots. If this proportion holds, a 9.2-inch gun will be inaccurate after 101 shots, which is almost double the number of shots attributed to the 12-inch gun, but this number will hardly be able to accomplish a result proportionately large.

These data are certainly of relatively important value, considering the fact that long experience along this line is lacking. The Krupps, in a mimeograph published in 1908, stated that this was an aspersion upon the efficiency of the 8.2- and the 11-inch guns, the former of which could fire 390 shots and the latter 192 without any appreciable diminution of either power or accuracy, and that in both cases the statement was backed up by proofs. Upon this hypothesis a 9.4 gun will have a life of about 280 shots, which should be quite sufficient for any need that is likely to arise in modern warfare; but the 192 shots possible with an 11-inch gun are likewise worthy of respect.

Let the matter rest here, for I believe that I would only be boring the reader, who would be willing to follow the matter to the end, if I went over all the arguments at my disposal, in an endeavor to convince him that it is not possible to use smaller caliber guns in coast defense work, without imperilling the defense of our harbors, or else putting our trust in howitzers.

The supporters of howitzers have good arguments, and are very persuasive, but the gun possesses one of the most important factors in warfare—moral effect—a point which cannot be passed over with impunity. If our guns are so located in batteries that they can respond to any fire, as necessary, I believe that blow for blow, considering the difficulties which the enemy is laboring under, they will be able to obtain a large margin of superiority, by producing both a material and a moral effect, which are of the utmost importance, whether the theater of operations be on sea, or land.

In conclusion I would simply say that we would be making a very grave mistake, if we were to abandon the course to which we have devoted so much attention, namely that of providing our seacoast batteries with the largest and most powerful guns which the skill of the gun-maker is able to produce.

—*Revista di Artiglieria e Genio*, May, 1911.

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SUBMARINE MINE DEFENSE OF COAST FORTRESSES*

(Continued)

Chapter V.

Passive Barriers

Barriers which can only serve to stop the enemy from advancing farther are called passive barriers. They may be divided into two very different classes: Immovable and movable barriers.

The former, representing massive and expensive erections, are capable of acting against all sorts of ships, beginning with liner steamers and ending with rowing vessels and submarine boats; they consist of moles, ballasted sunk chests and small heaps of stones. Although they present many advantages, their application is very limited, because:

(a) they may not be applied in many places, and only at comparatively small depths, not exceeding 30-40 feet;

(b) they demand considerable time for their erection, whole months and even years, wherefore their construction should be commenced simultaneously with the construction of the fortress;

(c) they are very expensive, which may be seen without further calculation and explanation (for instance, 1 sajen—7 feet—in length of ballasted sunk chests, 4 feet broad, sunk at a depth of 30 feet, costs about Rs. 1000 ($500);

(d) they require constant repairing, therefore their maintenance is also rather expensive;

(e) they encumber the water areas of the fortress; in times of peace they are a hindrance to all ships, both men-of-war and merchantmen and in times of war, to their own fleet.

Estocades should also be numbered among immovable barriers, but as they possess qualities which pertain also to movable barriers, we will examine them with these latter.

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* Continued from Journal U. S. Artillery, March-April, 1912.

The movable barriers, for action against small ships, and torpedo-boats, consist of booms and nets. Experience has proved that these barriers are incapable of stopping large ships, which pass them with impunity, either tearing them or submerging them; for small ships they are effective only if placed in two rows, at a distance of 300-350 feet one from another.

A boom consists of a certain number of separate beams (or bundles of beams) joined by chains or steel ropes.

A boom must be:

(a) sufficiently solid, so that the waves could not shake or loosen it;

(b) sufficiently light, so that its erection would not present any special difficulty;

(c) of simple construction, so that any repairs might be easily carried out;

(d) of sufficient buoyancy, so that ships could easily submerge this obstacle in passing over it;

(e) of sufficient elasticity, so as to develop gradually resistance to the pressure of ships, and

(f) it must have a passage open for their own ships, which may be formed either by placing parts of the boom *echelon* wise, or by covering the opening in the boom by a traverse, or by making part of the boom removable. This last method seems to be the best, as it makes the defense more reliable, and it is more simple for our own ships, although each passing out or coming in of our ships incurs a certain amount of work, which is, however, quite simple, if the boom is well constructed.

The following description shows a boom answering all the enumerated requirements, (Fig. 8). Across the area which it is proposed to bar, three chains or steel ropes are stretched, with a slackening of about 10%, supported every 35 feet by one, two or three, (as the case may be) beams, to which the chains are closely fastened (by cramps). The squares formed by the chains and beams are filled by nets of galvanized iron wire (each side of the square measuring 1 foot). On the lowest row of chains pieces of steel rope are hung and left dangling freely in the water; the nets as well as the ends of the ropes become entwined in the screws of ships attempting to force the boom. Small rafts are placed at the end of the permanent part of the boom, where the removable part commences; these rafts are laid on heavy upstream and lower anchors.

The removable part of the boom, joined to the permanent part by means of short pieces of chains, is divided into two halves, and each half, independently of the other, ends with small rafts; on each of the inner rafts A and B two winches are placed for hoisting the anchor chains; the heavy anchors are cast, as shown on the drawing. For opening the passage the upstream anchor chains on the rafts A and B must be eased off and the lower ones hoisted up, the rafts being previously unfastened one from another; for closing the passage, the contrary must be done.

In the permanent part of the boom up-stream and lower anchors should be placed at every ½ links.

The described boom should be placed in two rows, with a distance of 300-350 feet between them, and if constructed thus, we are of the opinion that it will answer all the requirements of a good boom, namely: (a) solidity, (b) lightness, (c) simplicity of construction, (d) buoyancy—to attain the latter, it is necessary in calculating the construction to make use of only half of the carrying power of the beams (deducting from the full carrying

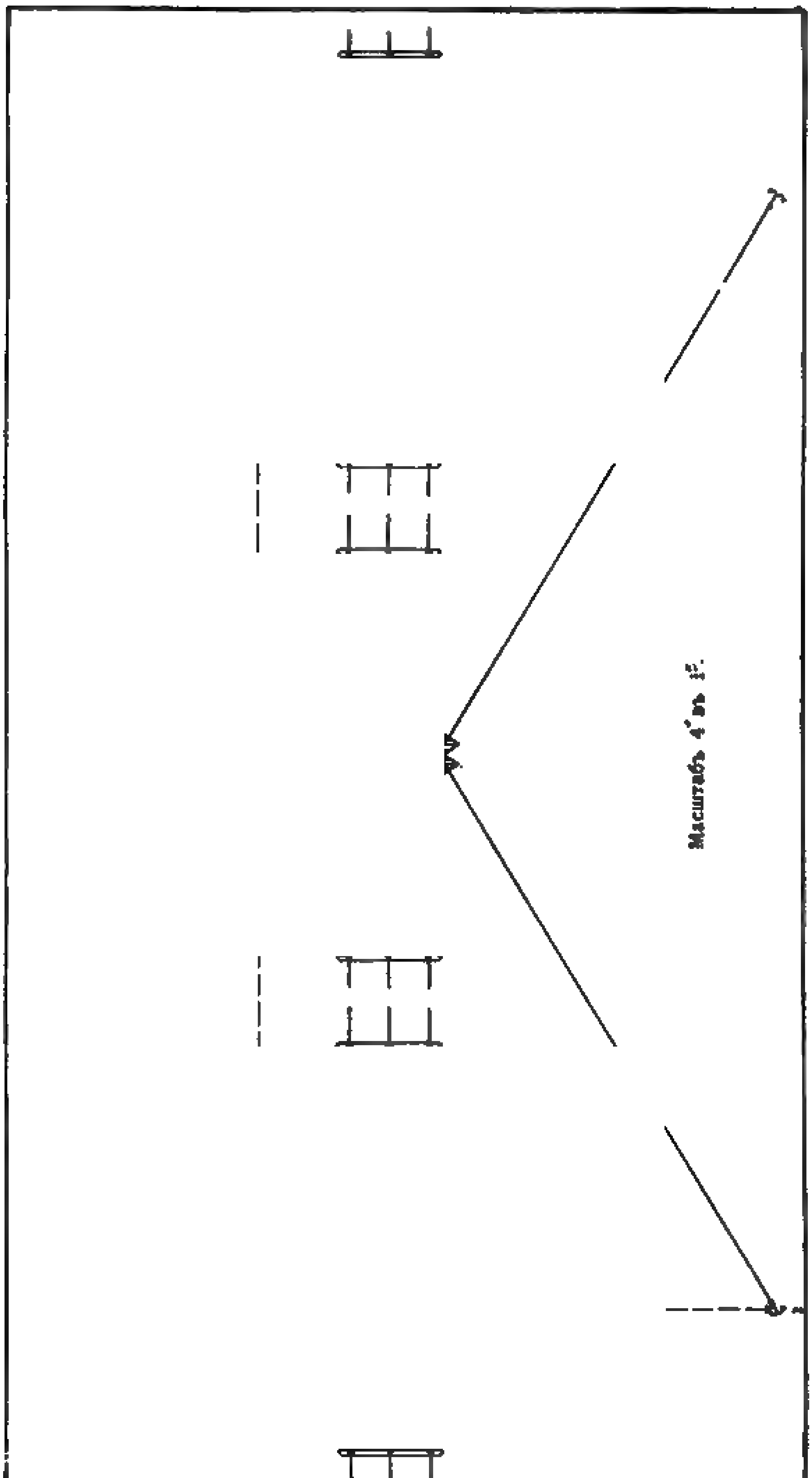


FIG. 8.

power of a dry beam: ¼ for the wetting, ⅜ for the weight of the nets, ropes, anchor chains, fastenings, etc. and ⅜ must be left free—for resistance against the ships which will be passing over), (e) elasticity, owing to the 10% of the length added by the slackening, and (f) openings for the passage of their own ships are provided.

Lastly, as the boom is placed in two rows, the ship passing over it will lose part of its speed in overcoming the first boom, consequently, when coming up to the second row at a slower course, it will experience another check, which is all that is wanted, as the booms must be placed under the near fire of the coast artillery. Naturally, the nets and ropes, fastened to the chains, may be torn off, but they will have done their business by becoming entwined round the screw of the ship and causing the ship to stop. The repairing of such a boom will not be difficult.

All kinds and systems of nets may be used, beginning with the simplest kinds, namely: A chain or steel rope with a vertical net hung on to the same (such a barrier may be hung across the strait on floats) and ending with most complicated constructions consisting of boats, chains and nets.

Experience has proved that nets of simple construction do not impede the course of torpedo-boats; they are easily torn by the boat screws. As regards the complicated kinds, they are not only very expensive and difficult of execution, but also the arrangement of a removable part for the passage of their own ships, and the opening and closing of the same, demand much time and labor.

Lastly, we must mention estocades, that is, rows of stakes driven into the bottom of the sea. These estocades can only serve as obstacles for small boats and can be applied only in shallow places, so that the cases for their application cannot be frequent.

The conclusions to be arrived at as regards passive barriers from the above description is, that:

a. The best passive barriers to be applied for the defense of coast fortresses, are booms.

b. Booms can be used only against small ships, therefore they *must* be applied in such fortresses, which serve as base for our active fleet when the latter may expect to be attacked by mines.*

c. Booms must be placed under the near fire of the machine-guns of the coast artillery, and

d. The construction of the boom must answer all the above mentioned requirements.

Chapter VI.

Mine Stations. Observation Posts

The mine stations are the nerve centers of the submarine mine defense of a coast fortress and therefore they must be made perfectly safe from destruction by the enemy's artillery fire (from land or sea) and fully equipped for the service for which they are destined.

The first part of the question belongs to the department of fortifications, we will proceed to the examination of the equipment of the stations.

The principal rules to be observed are the following:

1. The management of all the mine barriers should not be concentrated in one station; besides the danger thereof, pointed out in clause 3, the service of such a station would be extremely complicated. However, on the other

* And they must be applied in the defense of commercial ports and mouths of rivers.

hand, there should not be too many stations, as, besides the increased expense for the mine defense, it would involve an increased expenditure for the staff of the station, or if the staff in the fortress is limited, the men would be overworked.

2. The station must have a direct communication by telephone with the premises of the commander of the mine defense.

3. The sea ends of the cables must be perfectly guaranteed from destruction by the large guns of the fleet, because one must constantly bear in mind, that if the station be destroyed, the whole mine defense will be null.

4. Each mine station must have the following quarters:

a. Apparatus room.

b. Room for the commander of the station.

c. Room for the miners.

d. Sentry.

e. Storehouse.

f. Kitchen.

g. Toilet room.

h. Small landing place.

i. A signalling mast.

I. Stations for Electrocontact (Automatic) Mines

1. The number of stations depends very much on the locality; this is a question of tactics, and will be examined later on. From the technical point of view we think it is of no importance whatever, how many stations there will be, or how many cables will be conducted to each one of them, etc.

2. The question of telephone communication is so simple that we need not stop to discuss it. The only thing to note is, that the telephone between the station and the commander must be independent of all others. Otherwise at the approach of the enemy, it may happen that owing to the general confusion, all the wires may be taken up and the commander of the mining company (chief of the mine defense of the fortress) will be unable to phone to the station the order "to set the barriers ready for action." The idea of the likelihood of such a case occurring will oblige us to give up any wish to economize in a question of such importance.

3. As has been said before, the cables must be secured from the possibility of being reached by the shots fired from the artillery of the largest caliber. For this purpose, either beton or armor plate of corresponding thickness may be used, or even a layer of water of not less than 8 to 10 inches thick. The cables leading from the table in the apparatus room to a depth of 8 to 10 inches under the surface of the water, must be laid in a gallery of sufficient breadth in a trench dug for the purpose at a depth of over 8 feet and leading right up to the wall of the station building.

Without touching the constructive-fortification side of the question, we will express the wish that the gallery (should a gallery be constructed for the conduit of the cables) be of such dimensions as to allow a diver to carry out the necessary works freely and easily; for this purpose it would be necessary, 1st, for the dimensions to be not less than 7 feet in height and 5 feet in breadth; 2nd, the floor must have a slight incline, or better still, broad steps; 3rd, the cables should not be laid on the floor (as it would be difficult for the diver to move among them) but they must be fastened on the walls and the arched ceiling of the gallery; and 4th, the entrance into the

gallery from the sea must be of convenient access and covered with a fine net to prevent it from being choked up by sand, slime and small stones.

The question regarding the disposition of the stations belongs to the tactical part, but we may mention here some typical examples of such dispositions in connection with the depth of the coast and the direction of the enemy's fire. There may be two possible cases:

a. A coast, where the depth is over 15 feet.	(a) the cables may be conducted *only* from the front. (b) the cables may be conducted from the rear.
b. A coast, where the depth is under 15 feet.	(a) the cables may be conducted *only* from the front. (b) the cables may be conducted from the rear.

In the first case, if the cable is conducted from the front *only*, it will be necessary, probably, to construct a beton gallery, bringing the same to a depth of 21 feet (the breadth of the gallery being 7 feet, the thickness of the vaulting, 6 feet, and the thickness of the layer of water above the vault, 8 feet); should the cables be conducted from the rear, it will be sufficient to dig a trench of such depth that its bottom would be covered by a mass of water of 8 feet and even less, as the station building will serve as a traverse to the trench.

With a shallow coast the cables may be conducted only from the rear, as, to conduct the same from the front would require the erection of much too expensive works, therefore it will be best in this case to dig a channel 8 feet deep and bring it up to the rear of the station. Naturally, there are other ways of solving the question, but this is a matter of fortification construction, and we do not deem ourselves sufficiently competent on the subject.

4. The station itself must be a sort of barrack casemate. The floor must of course be at least 2 feet above the level of the waters at highest. The apparatus room, where the management of the mine barriers must be concentrated, should have only one entrance,—from the room of the commander of the station.

a. The apparatus room is destined to hold the requisite apparatus for the explosions and measurements. The area of the floor for each table (for 5 or 10 cords of main conduits) must be minimum 7 x 10 = 70 sq. ft. of which 5 × 5 = 25 sq. ft. must be occupied by three rows of shelves, with a space of 2-2½ ft. between shelves. It is best, however, to have all the tables in one room, counting at least 5 × 10 = 50 sq. ft. for each table, and the shelves for the batteries in a separate room nearby, or if in the same room, then behind a railing which may be locked up; a sentry should be placed near the railing to guard the batteries. The shelves must be made accessible from two sides, they must be able to hold a heavy weight (30 pounds on each shelf).

b. The room for the officer commanding the station requires no special description. It should be connected by telephone with the premises of the commander of the defense.

c. The number of miners in a mine station must be one noncommissioned officer and 5 men. With a large number of tables this figure must be

increased and one must reckon 3 men to each table, + 4 more for the whole station. Further each observation post belonging to a station must have at least 4 miners or sailors, and besides, if according to local conditions the guard cannot be relieved every day, there must be a relief guard consisting of 4 men. Thus, reckoning 3 tables in a station, we will require room for $(3 \times 3) + 4 + 4 + 4 = 21$ men. In case the station should be placed at some distance from the fortress and be serving some separately standing barrier, it should have: (a) a cover composed of part of the infantry garrison of the fortress and (b) a certain number of men from the mining company (not less than 25 men) for carrying out the necessary repairs in the barrier.

d. The guard room—for a post composed of 3 men and one officer in all 4 men.

e. Storeroom, near the apparatus room for the materials necessary for a mine station. Area of floor—7 square feet; shelves are desirable.

f. Kitchen.
g. Toilet room. } no special requirements.

h. Landing place—35 feet in length, 1½ to 2½ saj. (10½ to 17½ feet) breadth, 2 to 3 feet above the level of the water, when highest; it would be desirable to have one 1-ton derrick crane.

i. A signalling mast with a full complement of flags for giving and receiving signals from our own ships sailing out or returning home. It must be served either by sailor-signalists, or trained miners. It is a pity that this is not more attended to with us. The experience of the last war has proved (in Vladivostok) the desirability of introducing a course of marine signaling into the training of the mining companies.

II. Stations for Observation Mines

These stations consist of the same rooms and arrangements as the stations for the electrocontact mines. The only exception is the apparatus room for which the following conditions must be complied with:

1. The area of the floor for each group of 15 mines required for the installation of only the apparatus for the execution of explosions on observation must be estimated at $15 \times 15 = 225$ sq. ft.; if we add the necessary surface for the batteries, we have 250 to 270 sq ft.

2. Each apparatus must be placed in a separate chamber (the batteries of all the apparatus may have a common chamber with scaffolding shelves, reckoning for the batteries of each apparatus $5' \times 5' = 25$ sq. ft.). The chamber must be well protected so that the shots could not reach it; from an aperture made in it the whole area must be seen, where the mines are placed, from which the cables are conducted to the apparatus.

3. Not far from the stations, or better still, in the stations themselves strong searchlights must be placed with the exclusive object of lighting up the barrier formed by the observation mines.

4. The entire mine barrier must be divided by means of buoys into several parts, in correspondence with the different apparatus, destined to explode them. These buoys must be placed along the front of the mine barrier. At night time searchlights must be let onto the space in front of the mine barrier, in such manner that the inner facet of the light cone should fall on the buoys.

5. Special observation posts, which are necessary in the case of electrocontact mines (see further) are not needed here.

Observation posts are a necessary supplement to the stations for electro-contact mines. They must serve exclusively their special stations and mine barriers, and cannot be employed for any other objects (artillery, for instance, or others). The best way would be to have such an observation post above its station; from the latter (out of the apparatus chamber) a passage might be made leading to the post which could be connected directly with the apparatus chamber by means of a speaking tube. In case of need the commander of the station might pass into the post and personally undertake the observation. But if, according to local conditions, it would be impossible to have the post just above the station, it must of course be placed not far from it, and be reliably connected with it by means of a telephone.

We think that an observation post must be a solid construction so that the observing officer might carry out his responsible duties with *perfect tranquility*. The *Engineering Journal* for the years 1909 and 1910 gives good information on this point, so that a selection may be made of several systems mentioned therein.

The service of an observation post must be carried out by miners, or better still, by seamen. The observing officer must always have at hand: Excellent optical instruments, (telescopes, binocles), the silhouettes of our own and the enemy's ships, the distinguishing signals of our own ships, the established signal code, of our own fleet, etc. *i.e.*, all the "naval" information; this is why we think it would be better to appoint sailor-signalists to the service of the observation posts until the time when a course of naval signaling will be introduced into the programme of training of the mining companies, as has been said before.

In conclusion we must add that it is in the service of the mine stations and observation posts that the excellency of the organization of the defense of the fortress will be proved; such an organization must present a harmonious blending of all the forces and all kind of arms. In all coast fortresses, especially in large ones, serving as base for their own fleet, the sea and land forces must be on thoroughly good terms. Between the sea and land troops are the submarine miners (in the persons of their respective mine stations) and experience has proved that it is they who feel very acutely the least "friction between the departments" or any lack of organization. The land authorities must be informed of the actions and intentions of the naval authorities, but it is *the mine stations and observation posts who must always, at any moment, be in touch with all naval matters.*

In expressing this opinion, far be it from us to pretend to solve such important questions as to who should be placed at the head of the submarine mine defense of a fortress, in whose department the mine operations should be considered, or whether the management of the passive and active mines be given into the same hands, or everything be left as it is now, etc.; we only sincerely wish to have all these questions solved as soon as possible and not left until the time when, if still unsolved, they will become of acute importance, namely, in time of war. Then it will be too late!

Chapter VII.

Storehouses, Landing Places. Workshops

To finish with the subject of submarine mines from the technical point of view, we must say a few words on the necessary appurtenances of a mine station, namely, the storehouse, landing places, workshops, etc.

Storehouses: 1. for the mine property, 2. for the ship property, and 3. for the explosives.

1. Storehouses for the mining property had better not be concentrated in one point. It would be wiser to have them near the spots where the mine barriers will be placed. It may even be that the most rational method would be to have them near the corresponding stations. It is true that it will be less easy to guard them in times of peace, but certainly if circumstances demand it, the convenience of times of peace must be sacrificed to the requirements of times of war. On the other hand, the following consideration may be mentioned in favor of the concentration of all the storehouses, namely, that besides the facility of guarding the same during times of peace, they may be placed in a well sheltered spot beyond the range of the enemy's fire (although this will be hardly necessary; the storehouses being wanted only when the mines are kept in store, but when they are in the places destined for them, the storehouses will cease to be needed; and the reserve supplies for the mines may be kept in some other place).

For storing purposes the mine supplies must be divided into 4 classes: (a) the supplies to be kept in cold places, (b) in cellars, (c) in places which are heated, and (d) in the open air.

In regard to the dimensions of the cold stores we are of the opinion that for each floating mine with appurtenances an area of floor or scaffolding of minimum 3.5′ × 3.5′ = 12.25 sq. ft. will be required, with a height of 5 feet. For a ground mine the dimensions must be 5′ × 4′ = 20 sq. ft. with the same height.

Between the scaffoldings a railway must be laid, leading from the storehouses, as will be said further. There must be tracks, running on T beams fastened to the ceiling by differential tackle, calculated for one ton. Lastly, the mines should be placed in such manner that each one could be approached easily.

For the storage of the cables and India rubber appliances special chambers must be provided, in cellars,* with the simplest contrivances for maintaining an unvarying temperature in the same; the area of the floor may be calculated according to the quantity of cable to be stored, reckoning in the average, for 1 verst of cable 3′ × 3′ = 9 sq. ft. (including the passages) and 3.5′ in height; for the rubber parts one must add about 10′ for every 100 mines. The entrance into the cable cellar must be a broad one with sloping ramps.

The heated premises must have a floor area of 0.5 to 0.7 sq. ft. for each mine; cupboards and scaffoldings are also necessary.

As regards the area necessary for the storing of the supplies to be kept in *the open air*, it is not necessary to say anything on the subject.

The property to be stored in the above described storing places is mostly of a heavy and cumbersome kind, therefore besides the railway mentioned above, hand trucks will also have to be provided.

2. The storehouses for the storage of the ship property are placed near the water and their dimensions depend on the boats with which the mining companies are supplied: (1) If there are only rowing boats, each active mine section must have a building with a floor area of 100 to 125 sq. saj. (2) If the boats are provided with mechanical motors the question is considerably

* It seems to us, that the best way would be to keep the cables in the conditions in which they will have to act, *i.e.*, under the water. This system seems to be used in England.

more complicated; in urgent cases the boats can be allowed to winter in the water or be pulled ashore and left in the open air, sheathed with boards. For the engines storehouses will be indispensable.

One must be sure to provide facilities for pulling the ships ashore promptly and easily; the expenses incurred thereby must not be feared; it should be borne in mind that should these appliances be lacking in time of need one would be obliged to have recourse to private persons which would be much more expensive in the end.

3. *The storehouses for the explosives* must answer to the requirements of the "Regulations for storing, testing, receipt and delivery of pyroxyline" (3rd edition) and must consist of: (1) A magazine for the storage of moist pyroxyline. (2) A magazine for the storage of dry pyroxyline. (3) A laboratory. (4) A drying room. (5) A house for the guards.

The area of shelves in the magazine should be 1 sq. ft. for one pood of moist pyroxyline, and 2 sq. ft. for dry pyroxyline; the space between the shelves should be 3 feet. Moist pyroxyline can be stored in stone gunpowder cellars, posterns, casemates, etc.

The landing places must be in places sheltered from the waves. The length of a landing place for all the boats of each active mine section should be 40 saj. (280 ft.), the breadth not under 3 saj. (21 ft.), the height must correspond to the upper-works of the boats, consequently, about one-third of the whole length of the landing place (13 saj., or 91 ft.), must be about 10 ft. high, and the remaining length about 3 ft. The high part should have 3 movable cranes, one for hoisting a weight of 3 tons, and two for one-ton weights; the lower part must also have two one-ton movable cranes.

The locksmith and blacksmith workshops must be well equipped with all that may be needed, a joiner's workshop would also be desirable.

All the buildings and appurtenances enumerated in this chapter must be connected with one another by a portable railway system, the plan of which must be thoroughly worked out; in time of war, when the mine barriers will have to be set, the movement will have to go on rapidly, without stop or hindrances, which take up so much valuable time; therefore all must be thoroughly well planned out beforehand, viz: As to where the siding ways, turn-outs, turning platforms, etc., must be arranged. Of course, also the rolling stock must be in perfect order.

In concluding with this chapter the review of the technical part of a submarine mine defense far be it from us to affirm that we have correctly estimated the importance of each detail of this part of the subject and exhausted the question. We hasten to repeat, that the object of this article is to express our views on the subject which is of the greatest interest, but of which unfortunately very little has been said until now in print.

Part II.

TACTICAL DEFENSE

Chapter I.

General Rules for the Arrangement of a Defense by Means of Mines. Classification of Fortresses

Leaving aside the actions of a fleet within the zone of a coast fortress in the general sense of the term, let us examine which of its operations would

enable us to come to the assistance of our fortress by means of submarine mines.

We are assured that should the enemy attempt to:

1. Bombard the vital parts of the fortress.
2. Enter into an artillery duel with the artillery of the coast.
3. Break into the interior waters in the rear of the coast batteries.
4. Attack our fleet in the fortress by means of mines.
5. Block up the narrow entrances (if there be any) by means of fireships, then the submarine mines will prove to be powerful allies in the defense of such a fortress.

Of course, our fleet will have to conform its action to the importance of the fortress on the theater of war, and therefore it is necessary to establish in a general way the classification of fortresses and their purposes.*

Until now the artillery is considered to be the most reliable and up to a certain point the only means of defense, and the submarine mine is called upon to assist it in its combat with a fleet.

In order to ascertain in what way such assistance is to be given, we must first of all come to an understanding in regard to the distances from which the fleet may harm the fortress. From all that has been said on the subject in courses on fortification and artillery and in the unfortunately few articles in the military journals, we may come to the conclusion that in the present condition of sea and coast artillery:

1. The distance from which a bombardment can take place must be reckoned as equal to 18-20 versts (about 12 to 14 miles).

2. The distance at which an artillery duel may take place between a fleet and the coast batteries may be reckoned as 6-8 versts† (4-6 miles). Moreover, the breaking in of the enemy into the inner roadstead is dangerous only when it is carried out by large ships (with a deep-sea draft).

3. Mine attacks are carried out by the squadron torpedo-boats or the torpedo-boat destroyers, with a sea draft of not less than 8 feet.

4. In regard to the obstruction of narrow passages by means of fire-ships the experience of the last war must be borne in mind: Fire-ships move always in a straight line and being sprung by a submarine mine become submerged not before they have passed 1 to 1½ versts (2-3 to 1 mile) from the point of explosion.

Consequently, in defending a coast fortress the mines can:

1. Prevent the enemy from bombarding the vital parts of the fortress, for which purpose the mine barriers must be disposed at a distance of 18-20 versts from the point to be defended. Such barriers will be called by us offing barriers; we will reckon for the same 3 to 5 mines per sq. verst of defended zone, the breadth of the latter being equal to 2 versts.

The mines must be sunk to a depth of 16 to 20 feet, as: (a) the mines of such barriers are destined to act against large ships with a deep draft, from which alone firing at such great distances is possible; (b) the barrier is

* It is a known fact in the history of wars by the sea that no coast fortress was ever taken from the sea. Therefore the opinion enounced by H. L. Klado during his lectures in the Nicholas Academy in 1910, is of the utmost interest, inasmuch as he says that being fully aware of the tremendous advantages enjoyed by a coast fortress in a combat with a fleet, one may become too self-confident and even neglectful (if one may be permitted to use this expression) in the matter of its artillery equipment, the result being that in the history of wars by sea a fact unheard of before might occur—that of a coast fortress having been taken by a fleet "in sudden attack" (at a swoop).

† This figure is a most disputable point: some authors affirm that it should be equal to 4 versts (2⅔ miles); while others maintain 10 versts (about 7 miles); we take therefore the middle distance.

carried out far into the open sea where, at a considerable depth, the sea is rougher, and the waves should make the mines laid less deep (evidently automatic electrocontact mines) become closed. The mine groups by 5-6 mines on one main conduit are set in the form of a star, with a distance of 100-125 sajens (700-875 feet) from the magazine; consequently such barriers have the aspect of irregularly scattered groups of mines, it would be more correct to call such groups mine banks, or shoals.

2. Assist the coast artillery in a combat with the enemy's fleet, when the barrier may be placed at a distance of 6 to 8 versts (1 to 6 miles) from the battery of artillery. We will call such a barrier a *roadstead* barrier and we will reckon the number of mines requisite to be 5 mines per square verst in the points presenting less danger (for instance lying under the cross fire of the batteries) and 10 mines per square verst in more dangerous places, (for instance, the points from which our batteries may be flanked). The breadth of the zone of such a barrier must be reckoned as about 2 versts (1-1/3 miles); assuming the coast batteries to be the centers and drawing arches in radii of 6 to 8 versts from each center—we will obtain just such a zone. The mines may also be sunk at a depth of 16 to 18 feet, such a depth being justified by the above-mentioned motives. On one main line from 10 to 11 mines may be placed, the "stars" being applied on the flanks, and the "line" in the middle*; in any case these "line" groups must be disposed radiatingly, that is to say, across the probable course of the enemy's ships during their engagement with the coast artillery. Thus, such a barrier also has the aspect of irregularly scattered groups of mines.

3. Prevent the enemy's ships from breaking in into the rear of the coast batteries, hinder them from carrying out mine attacks and also prevent the enemy from obstructing the entrance by means of fireships. All these services may be carried out by one barrier, placed on the line of the coast batteries and at the same time carried out to a distance of 1½ to 2 versts (1 to 1½ miles) from the narrow parts. We will call it the barrier of *inner defense*. It represents an uninterrupted barrier, consisting of 2 to 3 rows of mines, placed across the probable course of the enemy's ships; the second row of mines is placed in chess-board order in regard to the first, and third row in the rear of the second one.

This barrier must have an opening for the passage of our own ships; a passage may be formed either by, (a) placing the barrier in *echelons*, or (b) by leaving an opening in the barrier, covered by a traverse, placed in front or at the back of the barrier, or (c) by leaving an opening in the barrier and placing at that point observation ground mines. The indispensable condition in the arrangement of a passage,—namely, to render it impossible for a ship coming from the sea to pass thru on a straight line (without changing its course)—must be especially complied with, if the barrier is destined to act also against fireships.

The above does not exhaust all the means of applying submarine mines for the defense of fortresses; they may and must be applied: (a) for abolishing dead spaces, should there be any; †(b) for preventing a descent ‡(c) for supporting the flanks of a position on land** and other.

* For the purpose of allowing our fleet to move out with a broad front.

† It will be opportune to remember the disposition of the mines at Liaoteshan in Port Arthur for the purpose of preventing indirect fire on the inner roadstead; near this barrier the "Hatsuze" and "Ioshimo" were distroyed.

‡ Dalniy; at the placing of the mines of the department of marine (there were no others)—the "Boyarin" and "Yenissey" were destroyed.

** Tsin-Djow.

We think it would be opportune to mention here also some general considerations:

1. For the main conduits of offing or roadstead barriers a many-corded cable (3-5-7) must be used; as otherwise it would be necessary to have an enormous quantity of one-corded cable, the laying of which would present great difficulties, if only in regard to the time required for the purpose. The rear of the roadstead barrier must not be encumbered by the main conduits, as in case the ships should have to be anchored in the exterior roadstead, the main conduits might be damaged. For this reason the main conduits must be laid along the coast.

2. The stations of the offing and roadstead barriers may be disposed on the line of the batteries of artillery; the barrier for the inner defense must have the stations placed behind these batteries.

3. The passages in the roadstead and inner barriers must have secret shuttings, (slides), which must be known on the shore, or there may be masts, which may be raised in case of need.* Naturally, all the passages and shuttings must be thoroughly well known to the whole staff of officers having to deal with the mine defense and to all the naval officers of the fortress.

4. Batteries of self-propelling mines must have a wide application in a passive mine defense; they must obligatorily be placed on the flanks of the roadstead and inner barriers, and perhaps even in the rear of the latter.

5. In front of each mine barrier it will be well to place in irregular order buoys and scatter at the bottom of the sea bits of chains, cordage, yarns, cables; all this may deceive the enemy in his efforts to ascertain the spot where the barriers are placed and endeavors to destroy the same (by means of mine sweeping ships and countermines) and make him lose his time in vain.

6. The defense of the barriers and mines as well as the sentry service must be laid on the *active floating* forces of the fortress; the torpedo boats of the coast defense, torpedo cutters, etc.

7. The clearing of the roadstead from the enemy's mines (mine sweeping) must be carried out with the help of a mining officer, and

8. *A point which we consider of the utmost importance.*

All the artillery officers of the fortress must obligatorily be called upon to participate in the projecting of the placing of the mine barriers. They must give suggestions not only on the plans, but on the location as well; they will be able to point out the weak points, so that they might be correspondingly fortified.

N. A. Buynitzki in his "Engineering Defense of States," divides the coast fortresses into four categories, namely:

1. Large fortresses.
2. Small fortresses.
3. Fortified coast positions.
4. Fortified regions.

A large coast fortress serves as base to its active line fleet and in case of need, as a temporary refuge.

Consequently, it must have:

a. Wharves, docks, stores, arsenals, magazines, etc., that is, all that may be called "the vital parts of a fortress."

* Or perhaps instead a submarine lighting of the passages by means of incandescent lamps. (A. Tasyglsky, "Contemporary Measures for Coast Defense," page 88.)

b. A free issue into the open sea, which it would be difficult to block up, and if possible, more than one.

c. A free inner roadstead, where there would be room for our own fleet.

Evidently, the vital parts must be guarded from bombardment. This purpose may be attained by carrying out the batteries of artillery to a requisite distance,* which we will assume to be equal to 9-10 versts (6 to 6⅝ miles). There are, however, fortresses which undoubtedly belong to the category of large ones, and in which the distance between the batteries of artillery and the vital parts does not exceed 2-3 versts (1½ to 2 miles); for the purpose of distinguishing these latter from the former, which fully answer all the requirements of "large" fortresses, we will call them hereinafter quasi-large fortresses.

It is obvious, that the enemy's fleet, operating against a large fortress cannot bombard its vital parts, because it will be prevented therefrom by the batteries of artillery, the large 10-inch and 12-inch guns of which will easily cover with fire at sight a distance of 10 to 12 versts; this would make 19 to 20 versts from the vital parts—so that a fleet would have to sustain an artillery duel with the coast batteries at the same time as it would have to sweep with fire these vital parts "in squares." Evidently, such a double task would be above its forces and it would have to give up the bombardment.

This serves to prove that a large fortress has no need of an offing barrier, but will only require a roadstead barrier and an inner one.

The mine defense of a quasi-large fortress has no batteries to defend the vital parts from being bombarded, and this duty devolves on the offing barrier; certainly, it will be only a half measure, but this is the only means of helping a quasi-large fortress to resemble a large one, to fulfill, so to speak, the functions of the latter. Naturally, besides the offing barrier, there must also be a roadstead and an inner barrier.

A small fortress serves as a base and refuge for small flotillas of cruisers and torpedo boats, whose destination is to execute sorties with the object of harrowing the naval communications of the enemy, impeding his descent operations and attacking separate vessels. The inner area of such a fortress is not large; this circumstance allows the position to be much less developed, that is to say, it brings the same nearer to the center.

It is hardly likely that the enemy will bombard such a fortress; (a) its inner area is not large, as we have already said; consequently, a sweeping fire "on squares" is difficult and will not justify the enormous expense of such an operation, and (b) there are no vital parts, for which reason, as we think, there is no need of an offing barrier.

The roadstead barrier may be much weaker than that of a large fortress; there is no need to place it in an uninterrupted line; possibly it may be found sufficient to bar only certain areas, where evolutions of a fleet are possible during an engagement with the coast batteries.

A barrier of inner defense must be placed only at such a point where large ships of the enemy may be able to break through to the rear of the batteries; in case there be but one issue in the fortress, the same must naturally be strongly defended against attempts to obstruct it by means of fireships.

Fortified coast positions (not disposed in a circle) are applied at such points where the conditions of the locality do not allow of the approach of large ships, the landing for a descent and the appearance of the enemy in the rear. (For example, the mouth of a river near a large fortress.)

* A disputable point.

We are of the opinion that in the sense of mine defense such coast positions may be compared to small fortresses, that is to say, they must be protected by roadstead barriers and a barrier of inner defense. It is possible that the first by its form (not by the idea thereof) will become a continuous line of barriers, resembling a barrier of inner defense, and it is possible, in such case, that there will be no need for a barrier of inner defense.

A fortified region consists of several fortresses (large and small ones and fortified coast positions) in mutual action together, the object of which is to protect several issues out of an interior water area common to all of them. The design of such a fortified region is therefore to serve as base and refuge for its own fleet, that is to say, to enable it to find support before the battle with the enemy, and in case of non-success in battle, to serve as refuge where the fleet could carry out the necessary repairs and recover its forces. For this object to be carried out successfully it is necessary that the fortresses of the same region be placed in such way, that the enemy's fleet would be unable to block up *all* the issues at the same time, one issue at least must always be free for the needs of our own fleet.

We think it is quite evident that the mine defense of a fortified region must be composed of the defensive measures carried out for all the separate fortresses which constitute the said region.

Having mentioned the above considerations, we may now declare positively that the locality has a tremendous and weighty importance in the question under discussion. Therefore, desiring to illustrate by examples all that has been said above on the subject, we will take a large coast fortress, a small one and a coast position and will draw a project of a system of mine defense for the same.

(To be continued.)

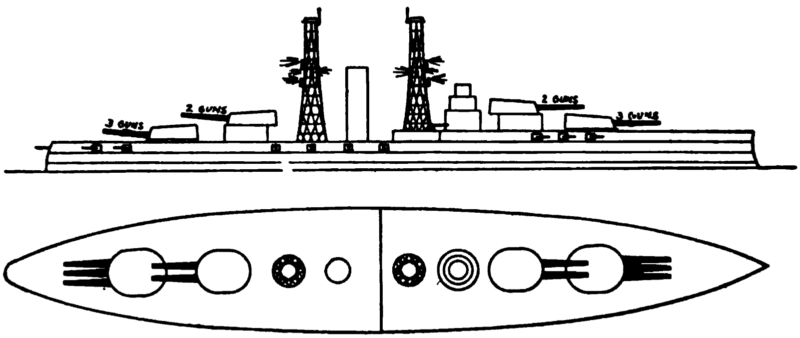
—*Engineering Review* (Russia).

THE THREE-GUN TURRETS OF THE NEW BATTLESHIPS

The announcement that the plans for the new battleships *Nevada* and *Oklahoma* contemplate not only the use of the new 14-inch 45-caliber guns, but

and additional turrets do not give a corresponding increase in fire and handiness. This is due to the fact that the fifth and sixth turrets cannot be installed high enough to fire over the tops of the others and they have, therefore, a large "dead arc." Also, because of the necessity for their location amidships, the magazines come in proximity to the boilers, and high temperatures result, which involve complicated installations for magazine insulation and refrigeration.

Thus is it apparent that it is advantageous to mount the main battery guns in four turrets, rather than in five or six. With four double turrets, eight guns is the limit; while with three-gun turrets, or a combination of double and three-gun turrets, it becomes possible to install twelve or ten main battery guns on a four turret ship. As the *Texas* and *New York*, which directly precede the *Nevada* and *Oklahoma*, have ten 12-inch guns in five turrets, the authorities were constrained to provide for at least as many on the latter ships, and an arrangement of two three-gun and two two-gun turrets was adopted, the double turrets firing over the tops of the three-gun turrets.



THE NEVADA AND OKLAHOMA

Length, 583 feet; beam, 95 feet 2½ inches; displacement, 27,500 tons; speed, 20.5 knots. Armament: Ten 14-inch, twenty-one 5-inch.

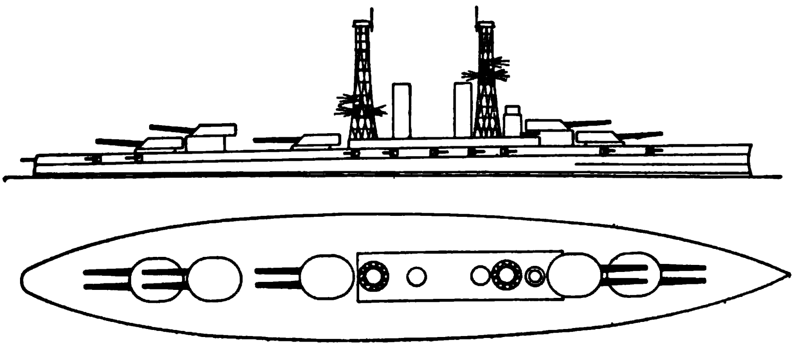
Another consideration that affects the three-gun turrets is the possibility they offer for firing in salvo, or simultaneously, all of the guns of one caliber in the ship. The advantage of this comes from the facility it offers in spotting the fall of the shot and judging the center of impact, in order to correct the range at which the sights are set. When the guns are fired singly, wild shots may be given undue weight by the spotters in correcting the range.

All things deliberated, the main consideration, and the one that, no doubt, brought in the three-gun turrets, just as it did the all-big-gun battleship, is the question of spotting. This is of the greatest importance in determining whether the shots shall hit the target, and the facility and accuracy with which it is done and the shots brought on the target will be large factors in determining the result of future naval engagements. Another obvious advantage of salvo firing is the possibility it offers of increasing the fire, by eliminating delays caused by the interference of guns, when fired independently, with the sighting and firing of the other guns.

Under conditions as they are understood now, concentration of fire on the enemy's ship as early as possible in the engagement is of the first importance, it being generally a foregone conclusion that the ship which gets in the first salvo will win the engagement, simply because the enemy's vessel will be disabled. The rapidity with which successive salvos are delivered and hits made, when the range has been found, may prevent the enemy from delivering in reply even a single broadside with accuracy.

Thus, concentration of the gun fire is of supreme importance, and this depends to a great extent on the number of guns that can be controlled and fired with a minimum of effort and risk of error. When the guns are pointed independently, even though fired in salvo, concentration is rendered more difficult by the greater chance for error in pointing, and the greater difficulty in spotting and setting the sights to the ranges as determined, which must be adjusted separately in each gun.

It is obvious, therefore, that in order to obtain the maximum efficiency from the three-gun turret, all the guns of each turret should be capable of being pointed as well as trained simultaneously, as one gun, that is, they



THE NEW YORK AND TEXAS 1112

Length, 573 feet; beam, 95 feet 2½ inches; displacement, 27,000 tons; speed, 21 knots. Armament: Ten 14-inch, twenty-one 5-inch.

should be fitted with a single elevating gear. There is of course the possibility that, in firing, there may be an interval between the actual time of discharge due to slower ignition of their powder charges, and the aim of the last gun firing would be thrown out by the shock of recoil of the other guns. Another valid objection to the three-gun turret is the greater loss consequent upon disabling such a turret.

The United States Navy is not by any means a pioneer in this field, as the Italians have laid down two classes of ships having the three-gun turrets; one type having three three-gun turrets and two double turrets, while the other has four three-gun turrets. Also, the Russians and the Austrians have laid down battleships having four three-gun turrets.

The foreign navies, it is understood, propose to fit the guns in their three-gun turrets, so that each is elevated and fired separately, as is at present the case in the double turrets, thereby failing to take full advantage of the possibilities the new turrets offer.

—*Scientific American*, January 27, 1912.

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OUR LATEST BATTLESHIPS, THE "NEVADA" AND "OKLAHOMA"

THE MOST POWERFULLY PROTECTED SHIPS YET DESIGNED

The navy has every reason to be pleased with the design of our latest battleships, the *Nevada* and *Oklahoma*, contracts for the construction of which have recently been let to the Fall River and the United States Shipbuilding companies. These ships represent, to a greater degree than any of their predecessors, the united experience and thought of the various branches of the naval service; and the officers of both line and staff unite in the belief that these two ships are the most powerful vessels afloat or under construction to-day. The armor plan is particularly effective and decidedly original, and in a comparison with previous vessels it will be noted that there are some very radical departures from existing practice.

The *Nevada* and *Oklahoma* are 500 tons larger than their immediate predecessors, the *New York* and *Texas*. The principal dimensions are: Length over all, 583 feet; beam, 95 feet 2⅝ inches; mean draft, 28 feet 6 inches. On this draft the displacement will be 27,500 tons. The *Nevada* will be driven by Curtis turbines and the *Oklahoma* by reciprocating engines. The boilers in both ships will be fired exclusively with oil, and they will carry no coal. The estimated speed is 20½ knots.

In an article published in the *Scientific American* of January 27th, 1912, we dealt at some length with the armament of these ships, and showed the considerations which led to the adoption of the three-gun turret, the chief of which was that, by elevating, training and firing the three guns together, great assistance will be rendered to the spotter in determining the fall of the shots, and he will be able to telephone the corrections with much greater accuracy than he could if the guns were fired separately. The armament will consist of ten 14-inch guns, carried in four turrets, disposed as follows: On the forecastle deck will be first a three-gun turret, then a two-gun turret. On the quarter deck will be a two-gun turret and astern of that a three-gun turret. This arrangement will give a concentration of fire superior to that obtainable from the ten 14-inch guns of the *New York* and *Texas*, which will be mounted in five two-gun turrets.

The new 14-inch, 45-caliber gun is a far more powerful weapon than the 45-caliber, 12-inch gun, mounted on the *Delaware* and *North Dakota*. The muzzle energy of the 12-inch piece is about 49,000 foot-tons, whereas that of the 14-inch piece is about 66,000 foot-tons. Moreover, its shell, which weighs 1,400 pounds as compared with the 870-pound weight of the 12-inch, carries a much larger bursting charge of high explosive and, therefore, will be proportionately more destructive.

The principal interest of the new ships lies in their great defensive power. Not only will they carry a much greater weight of armor than has been carried, or is to be carried, by any ship built or building, but the armor will be disposed to greater advantage. The chief duty of a warship is to maintain her stability and her mobility, and at all times present a completely-protected emplacement for her guns. In other words, she must not only carry her guns into the fight but she must nurse them through all its savage hammering, so effectually that they shall be able to pour shell into the enemy until they have silenced or sent him to the bottom.

So let us see how these conditions have been met in our new ships. Taking the *North Dakota*, for instance, as a basis of comparison, we find that

THE NEW UNITED STATES BATTLESHIPS "NEVADA" AND "OKLAHOMA"

Length, 583 feet; beam, 95 feet 2-5/8 inches; draft, 28 feet 6 inches; displacement, 27,500 tons; fuel, oil exclusively; speed, 20½ knots. Armament: Ten 14-inch and twenty-one 5-inch guns; torpedo tubes, four 21-inch. Armor: Belt 13½ inches; barbettes, 13 inches; turrets, 9 to 18 inches; smokestack, 13 inches; conning tower and tube, 16 inches; gun deck, 3 inches; protective deck, 2 inches.

the armor protection has been entirely removed from the secondary battery of 5-inch guns—a wise step, which might well have been taken several years ago. For it is a fact that the 5, 6 or 7 inches of armor with which the secondary batteries of warships of to-day are protected, will simply serve as a shell-burster, delaying the high explosive 14-inch shells long enough to cause the little firing hammer within the shells to leap forward and detonate the high explosive, the burst taking place after the shell has passed through the armor and is well within the body of the ship. So the torpedo-defense guns will have nothing in front of them except the ordinary ½-inch or ⅝-inch plating of the ships' side, which may very well allow the shells to pass through without bursting among the gun crews crowded about the guns.

The most important armor on a ship is undoubtedly the belt armor upon the hull itself; for to this is committed the duty of keeping the ship afloat and preventing projectiles from striking a vital blow in the magazine, boiler rooms or engine rooms. In the new ships the belt will be 17½ feet in width and, at mean draft, it will extend from 9 feet above to 8 feet 6 inches below the water. It will have the unprecedented thickness of 13½ inches, which it will maintain from its upper edge down to within a few feet of its bottom, where it will begin to taper to a minimum width at the bottom of 8 inches. Very rarely, if ever, will the bottom edge of this deep belt be rolled out of water, exposing the thin plating below. This belt will extend for over 400 feet along each side of the ship. It will terminate well forward of No. 1 barbette, where it will be carried, with the same depth and thickness, entirely across the ship. At its after end the belt armor will be carried at its full depth of 17½ feet to a point about 30 feet aft of No. 4 barbette. Here there will be a jog, the depth of the belt decreasing from 17½ feet to 8½ feet, at which depth it will be continued aft for another 60 feet. Transverse bulkheads of the same thickness as the belt will here be carried across the ship.

An important feature of the side armor is the manner in which the plating will be laid on the ship. Hitherto the armor has been placed horizontally, in two strips, with a continuous horizontal joint, located slightly above the water line, between the upper and lower strip. This had the disadvantage that is presented a continuous line of cleavage, near the water line, and, therefore, at a most vulnerable point. In the new ships the armor plates are laid vertically, the joints being vertical and the plating extending the whole depth of the belt without any continuous joint at the water line. This is a most important improvement which will add greatly to the protective power of the side armor. Associated with the heavy belt in the work of protecting the ship's stability are two protective decks—a lower deck 1½ inches thick on the flat which will slope along the sides to a junction with the bottom of the armor plate 8½ feet below the water line. The slopes of this deck are 2 inches in thickness. On the deck above (the gun deck) is an upper protective deck, 3 inches in thickness. These two decks provide an excellent protection against plunging fire, and also against fragments of shells which might be exploded in passing through the thin ship's plating in the wake of the gun deck.

Equally massive is the armor protection for the main gun positions. The barbette armor extends, with a thickness of 13 inches, from the turret down to the upper protective deck, and from the upper to the lower protective deck the thickness is reduced to 4½ inches—this because of the 13-inch

The armor plan of the NEVADA and OKLAHOMA, the two most powerfully protected ships yet designed. 1114

protection afforded by the side armor. The turret armor is equally massive. The port plate is 16 inches on the two-gun turrets and 18 inches on the three-gun turrets, and the side and rear armor is 10 and 9 inches in thickness, while the roof carries 5 inches of armor.

The battle of the Sea of Japan showed how important it is to thoroughly protect the positions from which the fighting of the ship is controlled, and particular attention has been given to this in our new design. The conning tower and the signal station back of it each carry no less than 16 inches of armor, and to protect the communications—telegraph and telephone wires, voice tubes, etc.—the section upon which conning tower and signal station are supported has walls of 16-inch armor, which are carried down to the protective decks.

It will be noticed that the new ships have but one smokestack—and thereby hangs a tale. The new ships, as already stated, will burn fuel oil exclusively. This has enabled the designer to dispense entirely with coal bunkers—the oil being carried chiefly in the double bottom of the ship. The omission of bunkers sets free a large amount of space below decks, which has enabled the designer to concentrate all of the six boiler compartments at the center of the ship, where they occupy only 65 feet of her length. Hence it was possible to use a single smokestack, placed immediately above the boiler rooms, and hence, again—and this is the important point, it was found possible to place around the whole of the uptakes a massive redoubt of inclined armor with walls everywhere 13 inches in thickness. This redoubt extends from the upper protective deck to the spar deck, and that portion of the smokestack and uptakes which is within the structure of the ship will be completely protected against perforation. The importance of this construction will be appreciated, when we bear in mind that, in the Japanese war, it was the perforation of the uptakes which contributed largely to the collapse of the Russian ships. The poisonous gases, escaping between decks, were drawn down and disseminated throughout the ship, frequently driving the crew from their quarters.

From the above description it will be evident that in the *Nevada* and *Oklahoma* the United States navy will possess two fighting ships which will be the equal, if not superior, to any ships in their gun power and which will be greatly superior in their power of endurance in a long-drawn-out fight. If Congress will only be wise enough to add year by year the two battleships which represent the minimum requirement of our navy, we shall be in a position to maintain our standing among the navies of the world. If less than two battleships a year be authorized, our navy will steadily retrograde.

—*Scientific American*, March 9, 1912.

Short Notes

French Heavy Guns.—The 1910 pattern 9.5-inch French gun, built for coast defense, has had to be withdrawn. One of these guns blew out its breechblock at proof in September, 1910; two months later a second burst explosively, the breech portion being blown to pieces; and three more of these guns have since shown signs of weakness. The cause is difficult to discover, since the only point in which this pattern differs materially from

earlier designs is in the breechblock, which is a new pattern of stepped screw. It fires a 500 lb. shell with charge of 147 lbs. of gun-cotton powder, or about the same charge and projectile as our own 10-inch, which is a heavier gun. Possibly the instability of the French powder is again in fault. If so, the French Navy will sooner or later be forced to abandon it in favor of cordite, which, with all its defects, is at least a safe propellant.

—*Army and Navy Gazette*, March 2, 1912.

Bomb throwing from aeroplanes has been abandoned in Tripoli. The bombs did not explode and they were recovered by Arabs, who used them against the Italian entrenchments. It also has been demonstrated by the experience of Lieut. Rossi while flying at a height of 1,800 feet above the enemy's encampment at Tobruk that rifle bullets are effective against an aeroplane at that altitude. Five bullets struck his machine and injured it, though not vitally. There were 20,000 aeroplane bombs shipped to Tripoli from Italy, however, and experiments are being made with an improved dropping apparatus. —*Army and Navy Journal*, March 9, 1912.

The New German Battleships.—Details of the battleship *Friedrich der Grosse* have been made public much earlier than has latterly been the practice in matters concerning naval construction in Germany. The *Nassau* class mount twelve 11-inch, twelve 5.9-inch, and sixteen 3.4-inch guns. The ships of the *Ostfriesland* class carry twelve 12-inch, fourteen of the secondary caliber, and fourteen of the anti-torpedo guns. A great change is made in the case of the *Friedrich der Grosse*, and it may be presumed that she is the type-ship of a class which will also include the *Konig Albert*, *Kaiser*, *Kaiserin*, and *Prinzregent Luitpold*. The displacement is increased. In the *Ostfriesland* class the displacement is 22,435 tons, but in the newer class it has risen to 24,500 metric tons. The remarkable feature is that the deck plan closely resembles that of the British *Neptune*. There are three turrets on the keel line, each mounting two 12-inch guns, one of them forward, and one of the aftermost pair firing over the other. Two other turrets with the same armament are on either side *echeloned*, the aftermost of this pair being on the port side. The number of guns is thus reduced from twelve to ten, but there will be a full broadside, with ahead fire of six guns and astern fire of eight. The length of the ships will be 564 feet 3 inches, the beam 95 feet 3 inches, and the draught 27 feet 3 inches. The additional displacement is devoted to obtaining higher speed and range of action. The details are given by the *Marine Rundschau*, and have also been circulated by the German Navy League. The engine power is 25,000, to give a speed of 21 knots. The normal coal supply will be 1,000 tons, but the total bunker capacity will be 3,600 tons. The diagram and a photograph of the model show that the *Friedrich der Grosse* will have two pole masts of ordinary type, and two funnels standing between them, but each near one of the masts. The ship is to be completed for service in the autumn of the present year, when the *Kaiser* is also due. These ships belong to the 1909 programme, and the others named above to the programme of 1910. The latter are not to be completed until next year.—*Army and Navy Gazette*, February 10, 1912.

NOTICES

MILITARY INVENTIONS

Arrangements have been made with H. B. Willson & Co., Patent Attorneys, 715 Eighth St., N. W., Washington, D. C., to furnish us lists of patents of interest from a military point of view. These will appear in each issue of the JOURNAL hereafter, if they seem to be of sufficient interest to our readers to pay for the space used. Give number of patent and enclose 10 cents to Willson & Co., for complete copy of any patent in which you are interested.

AERONAUTICS

1,025,210 Airship, J. E. Sheriff, Provo, Utah.
1,025,306 Apparatus for Aerial Navigation, R. R. Rawle and John Rawle, Chicago, Ill.
1,025,439 Internal Combustion Engine, Harry Whidbourne, Plymouth and J. J. Lishman, Salcombe, England.
1,025,482 Flying Machine, Burt Reid, U. S. Navy.
1,025,629 Safety Device for Aeroplanes, Jas. Kenefick, Chicago, Ill.
1,025,662 Dirigible Balloon, Abraham Mier Waxler, Philadelphia, Pa.
1,025,891 Flying Machine, James Walsh Northfield, Minn., assignor to J. H. Daunt, Minneapolis, Minn., and J. A. Walsh, Northfield, Minn.
1,025,912 Monoplane, R. H. Haag, Louisville, Ky.
1,025,941 Aeroplane, Rene Arnoux, Paris, France.
1,025,539 Airship or the Like, Frank Rosbory, Chicago, Ill.
1,025,548 Automatic Aeroplane-Equilibrator, J. C. Ten Eyck, Yonkers, N. Y.
1,024,670 Flying Machine, A. H. Blount, Detroit, Michigan.
1,024,676 Safety Device for Flying Machines, C. H. Burford, Meade, Kan.
1,024,766 Flying Machine, O. R. Cassell, New York, N. Y.
1,024,928 Aeroplane, Robt. Ensnault-Pelterie, Billancourt, France.
1,024,929 Aeroplane, Robt. Ensnault-Pelterie, Billancourt, France.
1,024,941 Aeroplane, Fred'k C. Lambert, New York, N. Y.
1,025,033 Aeroplane, Zachariah Fisher, Spokane, Wash.
1,025,063 Aeroplane, Jerry Hubschman, New York, N. Y.
1,025,085 Monoplane, J. A. Goodwin, Millville, N. J.
1,025,093 Flying Machine, Herman Jordan, Detroit, Mich.
1,025,106 Airship, Rudolph Anders, Bridgeport, Conn.
1,023,927 Flying Machine, Jno. C. Doty, Mount Vernon, Ohio.
1,023,937 Flying Machine, Jno. A. Jung, Cincinnati, Ohio.
1,024,011 Flying Machine, Roy L. Matteson, Santa Maria, Cal.
1,024,067 Hydroaeroplane, Emrico Forhanini, Milan, Italy.
1,024,102 Flying Machine, Alexis Rogestvensky, Moscow, Russia.
1,024,226 Apparatus Comprising Fans for Generating Progressing and Ascending Movements of a Body in a Fluid Medium, Max Reymond, Payerne, Switzerland.
1,024,287 Multiplane Airship, Eugene St. Sassil, St. Louis, Mo.

1,024,303 Aeroplane Engine Controlling Mechanism, Hugh L. Willonghly, Philadelphia, Pa.
1,024,315 Automatically Stabilized Supporting Plane for Aeroplanes and the Like, Pierre S. Detoble.
1,024,398 Equilibrator for Airships, Lighton B. Ellsworth, Portland, Ore.
1,024,407 Safety Device for Aeroplanes, Walter Lewis, Philadelphia, Pa.
1,023,429 Starting Device for Flying Machines, Karl Voller, Dusseldorf, Germany.
1,023,132 Indicator of Ascending and Descending Movements of Aerial Vehicles, Levitt Luzern Custer, Dayton, Ohio.
1,023,233 Flying Machine, Jno. Newton Williams, Derby, Conn.
1,023,367 Airship, Herman Faehrmann, New York, N. Y.
1,023,369 Apparatus for Aerial Navigation, Manfredo Ferrero, Turin, Italy.
1,023,404 Combined Boat and Airship, Jos. Wymore, Seattle, Wash.
1,023,484 Airship, Bruno Sitzenstok, Tompkinsville, N. Y.
1,023,534 Aeroplane, Geo. Nelson Spencer, Forest Grove, Oregon.
1,023,556 Aeroplane or the Like Analogous Machine or Device, Arthur Henry Edwards, Stoke, Newington, England.
1,023,667 Airship, Donald McKay MacLeod, Lake Charles, La.
1,023,682 Emergency Brake, Wm. Ray Reno, Louisville, Ky.
1,022,715 Airship, Sern P. Watt, Seattle, Wash.
1,022,777 Aerial Navigation, Henry Dissill, Washington, D. C.
1,022,793 Automatic Balancing Mechanism for Flying Machines, Lazar Lukacs, New York, N. Y.
1,022,903 Flying Machine, John A. Warrick, Chicago, Ill.
1,023,000 Aeroplane, Alcide E. Baudett, Albuquerque, N. M.
1,023,065 Air-Propeller, Jersey H. Buchanan, Midway, Texas.
1,023,096 Flying Machine, Jules Raclot and Camille Enderlin, St. Maur des-Fosses, France.
1,025,999 Flying Machine, Rudolph Salmen, Chicago, Ill.
1,026,079 Stabilizing Lifting Plane for Flying Machines, A. F. Dierdorff, Los Angeles, Cal.
1,026,219 Automatically Balancing Aeroplane, Marius Mathiesen, San Antonio, Texas.
1,026,304 Hydroaeroplane, E. P. Ekman, Chicago, Ill.
1,026,415 Automatic Steering Device for Flying Machines, R. M. Thompson, Tacoma, Wash.
1,026,490 Aeroplane, Vladimar Breuer, New York, N. Y.

ARTILLERY

1,026,590 Safety Breechblock Lock for Guns, Simon Jacobs, New York, N.Y.
1,026,597 Firing Device for Guns with Differential Recoils, Emil Muller, Dusseldorf, Germany, Assignor to Rheinische Metall-Waaren-und Maschinenfabrik, Dusseldorf, Derendorf, Germany.
1,023,976 Breechblock, Albert Wakefield, Washington, D. C.
1,022,469 Cartridge Extracting and Ejecting Mechanism for Breech-loading Ordnance, Arthur Trevor Dawson and Geo. Thos. Buckham, Westminster, London, England, Assignors to Vickers, Ltd., Westminster, England.
1,025,500 Projectile for Firing at Airships, Karl Wieser and Wilhelm Schwartz Brideney, Germany, Assignors to Fried Krupp Aktiengesellschaft, Essen-on-the-Ruhr, Germany.

13,406 *Reissue.* Projectile, Jno. S. Semple, Sewickley, Pa.
1,023,339 Shell, Alfred J. Soden, Newark, N. J.

SHIPS (NAVAL), ARMOR, ETC.

1,023,627 Armor for Battleships, Harriet G. Dawson, Atlanta, Ga.
1,024,424 Torpedo Launching Tube, Eugene Schneider, Le Creuzot, France.
1,022,676 Marine Compass, Harry Hertzberg, Brooklyn, N. Y.
1,022,784 Marine Compass, Harry Hertzberg, Brooklyn, N. Y.
1,022,785 Marine Compass, Harry Hertzberg, Brooklyn, N. Y.

SMALL ARMS, TARGETS, ETC.

1,022,973 Trigger Mechanism, Jas. M. Russell, Jonesville, Virginia.
1,022,945 Gun Cleaning Device, Wm. E. Hughes, Mineral Ridge, Ohio.
1,025,944 Collapsible or Falling Target, C. B. Elliott, U. S. Army.
1,023,741 Combined Firearm and Boxer, Bela Kreith, Budapest, Austria-Hungary.
1,023,169 Firearm, Jno. D. Pedersen, Jackson, Wyo.
1,023,966 Automatic Pistol, Henri Rosier, La Praelle-Herstal, near Liege, Belgium.
1,025,132 Automatic Gun or Rifle, W. M. Douglas, Galveston, Texas.
1,025,529 Butt-Stock for Shoulder-Arms, T. C. Johnson, New Haven, Conn., Assignor to Winchester Repeating Arms Co., New Haven, Conn.
1,025,550 Butt-Stock for Shoulder-Arms, W. H. Tilton, New Haven, Conn., Assignor to Winchester Repeating Arms Co., New Haven, Conn.
1,025,733 Small Arm, Hugo Borchardt, Charlottenburg, Germany.
1,024,651 Target, I. L. Reeves, So. Natick, Mass.
1,024,190 Firearm, John W. Dowden, Reeves, La.
1,024,932 Small Arm, Geo. Van der Haeghen, Liege, Belgium.
1,024,933 Small Arm, Geo. Van der Haeghen, Liege, Belgium.
1,024,989 Firearm, G. W. Gruver, Bakersfield, Cal.
1,026,068 Cartridge Belt, F. H. Batchelder, Worcester, Mass.
1,026,609 Automatic Firearm with Fixed Barrel and Locked Breech, Andreas Wilhelm Schwarzlose, Charlottenburg, Germany.

SUBMARINE MINES AND TORPEDOES

1,022,486 Heater for Automobile Torpedoes, Frank M. Leavitt, Smithtown, N. Y., Assignor to E. W. Bliss Co., Brooklyn, N. Y.
1,025,905 Automatic Firing Device for Submarine Mines, G. E. Elia, Paris, France, Assignor to Vickers, Ltd., Westminster, Eng.
1,025,747 Gyroscope for Automobile Torpedoes, A. E. Jones, Fiume, Austria-Hungary, Assignor to Messrs. Whitehead & Co., Fiume, Austria-Hungary.
1,023,832 Mine Anchor, Chas. R. Gabriel, New York, N. Y.

MISCELLANEOUS

1,022,526 Method of and Apparatus for Recording Marine Conditions, Howard Turner Barnes, Montreal, Quebec, Canada.

SIXTH CONGRESS OF THE INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS

This Congress will be held in the Engineering Societies Building, 29 West 37th St., New York City, September 2nd to 7th, 1912. The first day will be devoted to registration, acceptance of credentials and general arrangements. The following days will be well filled with lectures, excursions to places of interest in and around New York and some places at a distance, including Gary, Indiana, as about the maximum. The list of delegates includes official representatives of the governments of England, France, Spain, Switzerland and Sweden, besides many eminent men representing scientific societies and associations. The Secretary of the Organizing Committee having the Congress in charge is Mr. H. F. J. Porter, 1 Madison Ave., New York.

BUREAU OF MINES' PUBLICATIONS FOR FREE DISTRIBUTION

We have been asked to print the following notice:

DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

New Publications.

Bulletins. (List 9.—March, 1912.)

Bulletin 10. Use of permissible explosives, by Clarence Hall and J. J. Rutledge. 1912. 34 pp. 5 pls.

Bulletin 23. Steaming tests of coals and related investigations, September 1, 1904, to December 31, 1908, by L. P. Breckinridge, Henry Kreisinger, and W. T. Ray. 1912. 380 pp. 1 pl.

Technical Papers.

Technical Paper 8. Methods of analyzing coal and coke, by F. M. Stanton and A. C. Fieldner. 1912. 21 pp.

Technical Paper 10. Liquified products from natural gas; their properties and uses, by I. C. Allen and G. A. Burrell. 1912. 23 pp.

Technical Paper 11. The use of birds and mice for detecting carbon monoxide after mine explosions and fires, by G. A. Burrell. 1912. 14 pp.

Reprint.

Bulletin 34. Tests of run-of-mine and briquetted coal in a locomotive boiler, by W. T. Ray and Henry Kreisinger. 32 pp. Reprint of United States Geological Survey Bulletin 412. Copies will not be sent to persons who have received Bulletin 412.

The Bureau of Mines has copies of these publications for free distribution, but can not give more than one copy of the same bulletin to one person. Requests for all papers can not be granted without satisfactory reason. In asking for publications please order them by number and title. Applications should be addressed to the Director of the Bureau of Mines, Washington, D.C.

CORRESPONDENCE

Any communication received by the Editor, which the writer desires inserted, which is signed by him and which would be of interest to the readers of the JOURNAL from a military point of view, will be published in this department. It is especially desired to have questions asked and small items of information given. Questions asked in one issue will be answered in the next, where possible, by some person, or persons, who is considered to be capable of giving authoritative information on the subject involved. Answers or remarks, regarding any such question by any others will always be very welcome. The readers of the JOURNAL (and all others interested in it or its work) are most cordially invited to make full use of this department.

COAST ARTILLERY SCHOOL POWER PLANT

Fort Monroe, Virginia, May 20, 1912.

The Editor,
Journal of the U. S. Artillery,
Fort Monroe, Va.

Sir:—

Referring to an article in the JOURNAL, for May-June, 1910, "Operation of the Coast Artillery School Power Plant", wherein the statement is made: "While the present economy of the plant, operated at its present load factor, is shown to be considerable, the possibilities of increased savings to the Government by the utilization of present available energy, both heat and electrical, are greater," it may be of interest to the readers of the JOURNAL to publish the following statement of operation, with costs, of the School Power Plant, showing savings effected, for the year ending February 29th, 1912.

It will be noted that the saving in fiscal appropriation by Congress of funds for the supply of light and power, and heating school buildings, is over twenty-five thousand dollars, or within less than three thousand dollars of the annual appropriation for the support of the entire Coast Artillery School; so that the School Power Plant is at present saving nearly the entire fiscal cost of the school.

In this connection, also, it is interesting to compare the actual cost of coal for heating a double set of barracks at this post, and the entire school buildings, including the new Enlisted Men's Barracks, for a year. While the former cost is $1340.70 (for coal only), for heating 4000 sq. ft. of radiating surface, the latter cost $290.26 (for coal) for 8000 sq. ft. of radiating surface; *i.e.* 33.5 cents per sq. ft. for the barracks, and 3.6 cents for the school buildings, per sq. ft., or approximately one-tenth the cost of the barracks with separate heating plant.

Very respectfully,
OFFNERE HOPE,
Captain, Coast Artillery Corps,
Instructor, Coast Artillery School.

Operation of the Coast Artillery School Power Plant, Fort Monroe, Virginia. March 1, 1911 to February 29, 1912.

OUTPUT

Kilowatt hours at switchboard		
Post Lighting:		
Interior (buildings)	251109	
Exterior (street)	38012	
Total Light		289121
Power:		
School Laboratories	27675	
School Printing	3540	
Quartermaster Sawmill	851	
Quartermaster Pumping Station	40630	
Artillery, Fortifications	77826	
Total Power		150522
Total Output:		439643
Average output per day		1200
Total meter consumption, house lighting	236176	
Per cent. line and meter loss	6	

SUPPLIES USED

	Heating Build'gs	Tests	Live Steam Lab'y	Light and Power	Total
Coal, lbs.	199180	29096	78135	3087422	3393833
Coal, lbs., per Kw. hour	.45	.07	.18	7.0	7.7
Water, gals.	242500	23995	82350	3495265	3844110
Lubricants, gals.	0	0	0	410	410
Waste, lbs.	0	0	0	378	378

COST OF INSTALLATION

	Total	Per Kw.
Building and Machinery	$62248.43	$166.00
Distributing System	46769.59	125.00
Total cost	109018.02	291.00

COST OF OPERATION

	Heating Build'gs	Test	Live Steam Lab'y	Light and Power	Total	Cts per kw-hr Light and Power
Coal, $	290.26	41.53	111.41	4452.06	4895.26	
Water	25.45	2.52	8.91	363.60	400.48	
Lubricants				157.09	157.09	
Waste				30.24	30.24	
Paints, etc.				46.68	46.68	
Repairs				173.60	173.60	
Total Supplies $	315.71	44.05	120.32	5223.27	5703.35	1.19
Labor	66.15		17.40	5334.84	5418.39	1.21
Depreciation						
7% Machinery	32.49		13.81	4311.09	4357.39	.98
5% Distribution				2338.48	2338.48	.53
Total $	414.35	44.05	151.53	17207.68	17817.61	3.91
Cost of light and power at switchboard						3.38

SAVINGS EFFECTED BY THE OPERATION OF THE COAST ARTILLERY SCHOOL POWER PLANT, FOR THE YEAR ENDING FEBRUARY 29, 1912

	Former Cost, or Estimated Cost	School Cost A	School Cost B	Saving A	Saving B
House Lighting	$16539.32	$2983.27	$10496.36	$13549.05	$6035.96
Street Lighting	3120.00	452.64	1611.20	2668.36	1508.80
Pumping Station	2817.96	482.75	1373.29	2335.21	1444.67
Fortifications	3113.04	924.67	2630.52	2188.37	482.52
School Power	3206.60	380.94	1096.31	2825.66	2110.29
Laboratory Steam	300.00	120.32	151.53	179.68	148.47
Heating Buildings	1986.80	315.71	414.35	1671.09	1572.45
Total	31076.72	5659.30	17773.56	25417.42	13303.16

The cost of each item under the heading "Former cost," was calculated as follows:

House Lighting.—Meter consumption × 7 cents per Kw-hr.

Street Lighting.—Formerly paid for at yearly rate of $3120.00.

Pumping Station.—Formerly operated by steam power. The cost given includes only supplies and labor, (no depreciation).

Fortifications.—Former cost calculated on 80% efficiency of transformation, D.C. to A.C., and former price of 5 cents per Kw. hour.

School Power.—Estimated at 10 cents per Kw. hour, if produced by small School plant, for use of school ouly.

Laboratory Steam.—Estimated by adding to actual supplies used, the amount required for getting up steam.

Heating Buildings.—Cost of heating by separate heating plant, and calculated from actual tests made by this Department.

School Cost "A."—Supplies, maintenance and repairs only.

School Cost "B."—Total cost, including labor and depreciation.

Savings "A."—Difference in amount of fiscal appropriation by Congress.

Savings "B."—Net commercial saving, after setting aside depreciation, and paying all salaries of men on duty in the school connected with production of power. On an investment of $109,000.00 this saving represents an earning of 12.2 per cent.

PROBLEM IN THE USE OF THE RANGE BOARD

By Captain J. P. Hopkins, C. A. C.

Given the following data from firing trial shots with the 10-inch gun:

Actual range to target,	8000 yards.
Atmosphere r. n.	20
Wind, r. n.	30
Velocity assumed,	2150
Other conditions normal.	

The tug is at the left of the line of fire, 400 yards from the target, nearer the guns than is the target. The angle between the tug and the line of fire, measured at the target, is 60°.

The first shot was observed 400 mils short, observations reliable.

After the first trial shot, a correction was made in the assumed velocity that should increase the range of subsequent splashes 200 yards, in order that the subsequent shots, if short, should not be off the range rake, or out of the field of the camera.

The second shot was observed 220 mils short.

The third shot was observed 140 mils over.

The fourth shot was observed 100 mils short.

Find the velocity that should be assumed for record practice.

SOLUTION

Plotting the overs and shorts to scale: 1 inch = 50 yards, they are found to be respectively: —150, —91, +70, —44.

At range board, with ruler set at 8000 yards, determine first corrected range,

$$8000 + (-82) + 93 + 545 = 8556$$

With ruler set at 8556, determine second corrected range to be,

$$8000 + (-93) + 110 + 570 = 8587$$

With ruler set at 8587, the actual velocity of the first shot which was 150 short, is found by measuring 150 yards to the left of the 2150 velocity line, and is found to be 2123.

The velocity that was used for subsequent shots is found by measuring 200 yards to the left, and is 2114.

Determining the first corrected range with this new velocity, 2114,

$$8000 + (-82) + 93 + 735 = 8746$$

With ruler at 8746, the second corrected range is found to be,

$$8000 + (-97) + 18\ 118 + 780 = 8801$$

It is interesting to note that in order to increase the range of the splashes 200 yards, the corrected range must be increased 8801 — 8587 = 214 yards.

With ruler at 8800, the actual velocity for each shot is found to be

2nd shot, 44 yards short, actual velocity	2107
3rd shot, 70 yards over, actual velocity	2127
4th shot, 91 yards short, actual velocity	2099
The first shot was found to have velocity	2123
	4)8455
Mean velocity to be assumed for record shots	2114

Or: the first shot if fired with the 200 yards increase in range given the other shots would have fallen 200 yards nearer the target, that is, it would have been + 50

The second shot was	— 44
The third shot was	+ 70
The 4th shot was	— 91
	4)— 15
Center of impact,	— 4

which gives 2113 as the velocity to be assumed.

A MANUAL FOR POST AND DISTRICT ORDNANCE OFFICERS

By Captain Mark L. Ireland, Coast Artillery Corps

Author's Note

The author has been prompted by his own mistakes and failures to suggest the codification of the methods and practices of ordnance officers. The proposed work would appear to serve the following purposes:

a. To provide a guide for the inexperienced officer or soldier entering upon post or district ordnance duty.

b. To unify, in as far as may be desirable, the practice in the several posts and districts.

c. To afford to those concerned the benefit of the conceptions and experience of others.

d. To facilitate the assumption of the duties and projects of one's predecessor without the upheaval, the stagnation of business, and the period of adjustment to new conditions and practices now so noticeable.

e. By some concert of action to progress toward a greater efficiency of service.

It is not the author's purpose to assume the role of an instructor of ordnance officers but rather that of a volunteer compiler. Each energetic ordnance officer and ordnance sergeant has developed something great or small that is worthy of consideration and, if not of adoption outright, of adaptation to conditions common to all districts. A circular letter published in the JOURNAL for May-June, 1911, page 370, having met with a considerable show of interest but with rather scant returns in the way of suggestions, the author is compelled to offer, for suggestion and criticism, the subject matter, chapter by chapter, as rapidly as his duties permit its preparation. The chapter on "Armament Caretakers" follows. It is mainly an adaptation to ordnance work of the chronologically tabulated scheme of Captain James A. Moss, 24th U. S. Infantry.

It should be borne in mind that what you think of the matter offered is of value to the author and to the idea, only if made known to him. Your criticisms, favorable or unfavorable, are evidence of interest in the subject for the subject's sake. If this interest is deep enough to have an assignable value, false modesty about "rushing into print" will not deter you from taking the action necessary to make your opinions and your experience known.

Much is now written about the Army's "burden of paper work." But yesterday all the world began to inquire, "What does this phrase 'Scientific Management' mean?" Paper work multiplies several fold under scientific management. Reduction of the former and adoption of the latter are questions which will not down. If we escape criticism, as being unprogressive, and the enforced acceptance of new methods devised by others not as well prepared as ourselves to judge of their merit, we must meet these questions with a solution that will work in war. No one of us, single handed can solve the problem but we must live and work with what the "Business Efficiency Commission" prescribes when its watchful eye has reached us. No Congress will worry about "attaining efficiency at the expense of regular officers and soldiers." Therefore let us be ready to show that the application of "Scientific Management," in so far as it is applicable, has begun, and that it is accompanied by a maximum reduction of paper work.

ARMAMENT CARETAKERS

GENERAL DISCUSSION

Armament caretakers are men detailed on special duty, under charge of the ordnance officer, to care for the ordnance property pertaining to batteries out of commission. They attend such drills, inspections, and other duties as the commanding officer may prescribe. They are selected from 1st class gunners or men having a special knowledge of machinery who know how to care for and make simple adjustments on the same. No difficult adjustments or repairs are allowed to be made by the armament caretakers.

Each man must take an active interest in his work and try to make his gun, carriage, emplacement and equipments an example of neatness. His reward comes through the reputation he establishes for industry, reliability, and attention to duty, through personal satisfaction in knowing that his duty has been well done and that it will most certainly count for him when a man is desired for advancement.

SCOPE OF WORK

The caretaker looks after the gun, carriage, ammunition, tools, trucks, accessories, the magazines, emplacement, parade, parapet and the fire control equipment in the emplacement to which he is assigned. Any serious damage to, or defect in the engineer, signal corps, or ordnance work or property should be reported promptly to the ordnance officer or the ordnance sergeant. The caretaker should be able, and should be instructed, to make minor repairs about the battery, such as cleaning drains and sumps, replacing broken lanyards, repairing breech and muzzle covers, wooden covers for piston rods and the like. He is not to alter electrical circuits nor to attempt to make repairs thereon, nor make any alterations on the armament and accessories.

The caretaker should be carefully instructed in his duties. It is the purpose of what follows to show him exactly what is expected of him in preparing for, and at, inspections of the battery.

GENERAL INSTRUCTIONS

1. Ask the ordnance sergeant for ordnance pamphlets pertaining to the materiel under your charge and study the workings of the different parts. Give special attention to the instructions in italics.
2. For detailed information in regard to the differant oils, paints, and materials used for cleaning and preservation of seacoast guns and mortars, carriages, sights, and position-finding instruments, refer to ordnance pamphlet No. 1869 as amended by Cir. No. 29, W. D., 1910; for the care of the breech mechanism refer to No. 1665.
3. Keep all materiel free from *rust.*
4. Keep all oil-holes clean and well supplied with synovial, or engine-oil No. 1.
5. Before painting or oiling a surface, make sure that it is *clean* and perfectly *dry.*
6. Recoil cylinders must never be left empty or even partially empty.
7. Never use a steel hammer directly on any part of the gun or carriage. Put a piece of board or copper in between, or, better still, use a copper hammer.
8. After cleaning a surface with kerosene make sure that all of it is removed before applying a coat of oil. Kerosene contains a very little acid which will rust metal with which it remains in contact.

Things Required to be Done at Fixed Intervals

ANNUAL SCHEDULE

This arrangement has been made to suit climatic conditions, in the Department of the Columbia, and the monthly schedule of inspections, prescribed in G. O. No. 14, Artillery District of the Columbia, by which the District Commander distributes the District Inspection over the Fridays of the month, thus reducing the time devoted to battery and district inspections to a minimum. This also allows time for more careful inspections when desired. This should be varied by the Distict Officer to suit the local conditions of his district.

Time in month before inspection	Nature	Authority	Remarks
January			
4th Week	Empty and refill recoil cylinders.	¶15, A.M. No. 1, 1904	Par. 869 C.A.D.R. prescribes the interval only in the case of pedestal mounts.
	Coat all exposed surfaces of gun and carriage with a thin coat of light slushing oil.	865 and 862 C.A.D.R.	
3rd Week	Paint ammunition trucks, shot tongs, differential hoists. Coat chains with mixture, half boiled linseed oil and half turpentine.		
February			
4th Week	Paint interior lighting and power cables, mouldings, trolley rails, interior sides of doors, non-electric parts of shot hoist, implement racks, projectile skids, speaking tubes except brass and hose parts, electric conduits, water pipes, iron hydrants, etc.		
3rd Week	Whitewash magazine and gallery walls, whitewashed niches and places protected from the weather.		
March			
4th Week	Clean and varnish armament chests, battery boxes, firing mechanism boxes.		
3rd Week	Varnish woodwork in lavatories. When varnish is worn in spots, the old coat must be removed with sand paper and two coats applied. Oil must not be used over varnished woodwork. Apply coat of aluminum paint to all lavatory parts on which this preservative is ordinarily used.		
2nd Week	Give parade, parade slope, superior and exterior slopes and the vicinity of the battery a thorough policing. Loosen earth around all trees and shrubs planted for concealment of battery.		

Time in month before inspection	Nature	Authority	Remarks
April			
4th Week	Clean recoil cylinders.	¶ 15, A.M. No. 1, 1904	
	Paint interior parapet walls, walls of traverses and parade walls, and then horizontal concrete surfaces when the latter are required to be painted.		
3rd Week	Coat all exposed surfaces of gun and carriage with a thin coat of light slushing oil.	856 and 862 C.A.D.R.	
	Paint vertical exterior iron- and woodwork of emplacement and davits.		Vertical surfaces when freshly painted suffer less from showers.
2nd Week	Clean traversing rollers and paths. When carriage is one of the models requiring the removal of a section of dust guard, leave all but four or five bolts out of section, *wrapping them carefully in paper and putting them in armament chest* until after inspection. Dust guards of this type will be removed in April, June, August and December only. Paint balance of exterior iron- and woodwork. Whitewash niches in exterior walls.		
Wednesday 1st Week	Scrape slushing oil from chamber and bore. Sponge out thoroughly, recoat with a *thin* coat of light slushing oil.	856 and 858 C.A.D.R.	
May			
4th Week	Scrape and paint cannon.	851 C.A.D.R.	
1st Week	Renew numbers on cannon.	855 C.A.D.R.	
June			
4th Week	Scrape and paint carriages.	852 C.A.D.R.	
2nd Week	Fill all grease cups whose spring rods do not project. See traversing roller guard note in April.	Carriage Pamphlet	

Time in month before inspection	Nature	Authority	Remarks
July			
4th Week	Empty and refill recoil cylinders.	¶ 15, A.M. No. 1, 1904	Par. 869 C.A.D.R prescribes the interval only in the case of pedestal mounts.
	Water the slopes and parade as prescribed for 4th week before inspection in August.		
	Raise mortars from trunnions beds and clean.	863 C.A.D.R.	This should be done when mortars are dismounted.
	Dismount mortars. Clean and overhaul.	864 C.A.D.R.	Pit A should be dismounted in odd, and Pit B in even, numbered years.
3rd Week	Water slopes and parade as prescribed for 4th week in Aug.		
	Coat all exposed surfaces of gun and carriage with a thin coat of light slushing oil.	856 and 862 C.A.D.R.	
	Water slopes and parade as prescribed for 4th week before inspection in August.		
2nd Week	Water slopes and parade as prescribed for 4th week before inspection in August.		
Wednesday 1st Week	Water slopes and parade as prescribed for 4th week before inspection in August.		
August			
4th Week	Paint interior lighting and power cables, mouldings, trolley-rails, interior sides of doors, non-electric parts of shot hoists, implement racks, projectile skids, etc.		Exterior painting should be deferred on account of insects and dust.
	Water the slopes and parade once thoroughly before 9 a.m. or after 4 p.m.		
3rd Week	Whitewash magazines and gallery walls and other whitewashed places. Water the slopes and parade. See 4th week above.		
2nd Week	Give parade slopes, superior and exterior slopes a thorough policing.		
	Water the slopes and parade as prescribed for 4th week above.		

Second Week Before District Inspection

1. Do the work assigned to this week of this month in the annual schedule.
2. Inspect drains and sumps and put them in order. 843 C.A.D.R.
3. Traverse the piece on Friday to the center. 843 C.A.D.R.
4. Examine traversing rollers and paths. Clean in April, June, August and December and such times as examination shows it to be necessary.
5. Oil cannon, carriages and ammunition trucks at all oil holes, using a moderate amount of oil. Wipe up overflowing oil. *Clean all oil holes before oiling.*

Monday Before District Inspection

1. Clean out armament chests, cleaning material boxes, etc.
2. Clean tools, firing mechanisms and accessories. Touch up paint on sponges, rammers, extracting rods, steel scrapers, slush brushes, staves and rammer props.

Tuesday Before District Inspection

1. Inspect the drains and sumps and put them in order. 834 C.A.D.R.
2. Clean out counterweight well and drain holes from base ring pockets.
3. Try all swinging and sliding doors and oil hinges lightly. Remove all dripping oil.
4. Try all cranes and oil bearings of same.
5. Clean lavatories thoroughly. Remove all stains from the porcelain. Touch up rusty metallic parts with aluminum paint, first removing all rust.

Wednesday Before District Inspection

1. Scrape slushing oil from chamber and bore. Sponge out thoroughly. Recoat with *thin* coat of light slushing oil. This will be done only in April and November unless dry or rust spots show. 856 and 858 C.A.D.R.
2. Oil cannon, carriages and ammunition trucks at all oil holes using a moderate amount of oil. Wipe up overflowing oil. *Clean all oil holes before oiling.*
3. Coat wire retraction ropes with raw linseed oil.
4. Clean oil from painted surfaces and from platform.

Thursday Before District Inspection

1. Sweep out magazine, galleries and rooms.
2. Inspect piston rods, recoil rollers, recoil roller paths, cross-head guides, retracting drum, retracting rope sheaves, retracting pulley, sight arm and steel stop points of electrical controllers for rust. Slushing oil will be removed and a very light coat of lubricating oil applied, from May to October, inclusive, except during stormy weather. At other times an effective thin coat of light slushing oil will be maintained.
3. Fill recoil cylinders.
4. Test the traversing mechanism by moving ten degrees to the right of the center, then ten degrees to the left of the center, then back to the center position.
5. Make sure that retraction clutch is out of gear and attach ropes to gun lever hooks. Hemp retracting ropes will not be attached to gun levers before tripping. When special instructions have been given that guns will

not be tripped at inspection, the ropes will not be run out until the time prescribed during inspection.

6. Test the elevating mechanism and bring guns to an elevation of 5 degrees, mortars so that their axes are parallel to the piston rod. See 860 and 861 C.A.D.R.

7. Make your final inspection of bore, chamber, breech recess and breech mechanism.

8. Wipe off shot trucks, receiving tables, hoist, armament chests, tables and other furniture.

The Morning Before District Inspection

1. Open all doors except powder magazine door.
2. Throw on all lights, switches and report at once to non-commissioned officer in charge of battery, or to electrician sergeant, all lights which do not burn.
3. Sweep emplacement and steps to same.
4. Bring up rammer prop, rammers, sponges, slush brushes, scrapers and extracting rods. Place the tools on rammer prop, heads toward the projectile hoist, prop nearly in rear of breech but slightly to the side opposite projectile hoist. When hooks outside the rail are provided for the rammer, place the rammer on them and other tools on the rammer prop conveniently near.
5. Open armament chests.
6. Bring up translating roller (or operating crank), obturating nut wrench, obturator nut clamp screw wrench, tit wrench for obturator, firing mechanism, lanyard, screw driver for hinge pin oil hole screw, filling plug wrench, half pint oiler and some clean waste.
7. Remove breech and muzzle covers and lay them at the place prescribed for each battery.
8. Clean all free oil from the breech recess, block mechanism. The oil should not be removed from bearing surfaces unless it is free, that is, present in excess of the needs. Insert translating roller (or attach operating crank).
9. Put on firing mechanism. If rainy, or foggy, replace breech and muzzle cover until the inspector appears.
10. Remove piston rod covers, filling plugs, and drip pans.
11. Put sight in place.
12. Remove traversing roller opening cover. If dust is blowing, or if it is rainy, loosen the cover only. Remove the cover when the inspector approaches the opening. When the carriage is one of models requiring the removal of a section of the dust guard, the section will be removed in April, June, August and December only.

ARTILLERY INSPECTION

"The armament is manned, instruments adjusted, and everything prepared for service." Par. 621 C.A.D.R.

"The inspector visits the stations and emplacements in such order as may be most convenient. During the inspection of a command, he is accompanied by its commander." Par. 622 C.A.D.R.

"When the inspector approaches a gun emplacement, the gun commander commands *Attention, Open Breech,* and gives such other commands

as may be necessary for the execution of the inspector's instructions." Par. 626 C.A.D.R.

"As the inspector enters the pit of a mortar battery ,the pit commander commands, *Attention, Prepare for Inspection,* and as he approaches each piece, the gun pointer commands, *Open Breech,* and such other commands as may be necessary for the execution of the inspector's instructions." Par. 626 C.A.D.R.

The usual order of inspection at gun batteries is as follows:

No. 1 Emplacement,
No. 2 Emplacement,
No. 3 Emplacement,
No. 3 galleries and magazines,
No. 2 galleries and magazines,
No. 1 galleries and magazines.

All caretakers assemble at the breech of the first gun to be inspected taking the posts of members of a gun section corresponding to the numbers of the guns to which they are assigned.

Breech Mechanism

After the breech is opened and the bore and chamber have been inspected, No. 2 turns the mushroom head. When directed to drop the split rings for inspection, the firing mechanism is removed, the obturator nut clamp screw is loosened, then the obturator nut, until the spindle can be pulled forward about one inch. The front split ring is then dropped for inspection, raised, the gas check pad pushed forward and the rear ring dropped for inspection. The pad and mushroom head are then adjusted as prescribed in Par. 873, C.A.D.R. When notice is given in advance that the split rings will be inspected, the firing mechanism should be left off until after the inspection of the rings has been completed. The breech is closed. Oil the hinge pin in the presence of the inspector. Remove the translating roller.

Firing Mechanism

The inspector makes such tests as he desires. Remove the firing mechanism before tripping the gun.

Safety Lanyard Attachment, Guns

Non-commissioned officer in charge of battery will press down the pawl to allow the inspector to draw out the reel cord.

Elevating Mechanism

Caretaker No. 1 as soon as the breech has been closed, mans the elevating wheel and first elevates and then depresses the gun while the inspector is going around the carriage, usually from right side across the front to the left side.

Traversing Mechanism

Caretaker No. 1 mans the left crank and No. 2 the right crank and, in the absence of specific instructions, traverse to the right until ordered to halt and then traverse to the left until the command, *Halt,* is given.

Recoil Cylinders

As soon as the fact that the cylinders are full has been verified by the inspector or person designated by him, Caretaker No. 1 replaces the filling plugs and sets them up tight with the wrench. The non-commissioned officer in charge will see that the filling plugs are firmly set up before giving the command to trip.

Tripping Mechanism, Disappearing Carriages

Note the precautions under 5 on "Thursday before District Inspection", which are to be taken to insure the carriage being ready to trip. Caretaker No. 1 mans the tripping lever (if any) on the left side and No. 2 the lever (if any) on the right side. They trip the gun at the command, 1. *In battery,* 2. *Trip,* given by the non-commissioned officer in charge. When the gun is not to be tripped on account of the weather, or other cause, the retracting ropes and drums may be inspected by running out the ropes by the command, 1. *Man the retraction ropes,* 2. *Run out,* when Nos. 1 and 2 man the right and left ropes respectively and run them out.

Electric Power Equipment

When the carriage is equipped with a retracting motor and power is available, the gun will be tripped twice and will be retracted first by power and then by hand. Retraction by hand is the surest way of detecting faults in the retraction system. In order not to delay the inspection the inspector will usually order hand retraction to cease when the carriages are about 6 inches out of battery. Releasing the retraction clutch and allowing the gun to run into battery affords a good test of the counter recoil system. See carriage pamphlets.

Sight

Test of the sight and the means within reach from the sighting platform for laying the sight will be made by the inspector, or person designated by him.

Implements and Accessories

Rammers, sponges, slush brushes, scrapers, extracting rods and ammunition trucks are inspected enroute to the projectile hoist. Hose will be attached to hydrants and water turned on and off as the inspector passes. Where water is supplied by force pumps on the parade, the pumps will be operated as the inspector passes them.

Doors, Shutters, Windows and Cranes

Doors, shutters, windows and cranes will be swung, moved, or raised and lowered, as the case requires by caretakers who keep in advance of the inspector for this purpose. Par. 628, C.A.D.R.

IMMEDIATELY AFTER INSPECTION

1. Unless the guns are to be left in battery to facilitate work upon them, the caretakers will be assembled from adjacent batteries after inspection is over and will retract all guns on disappearing carriages under the supervision of the non-commissioned officer in charge of the batteries. Where the number is insufficient, a suitable detail will be ordered to report to the non-commissioned officer in charge (usually at 1 p.m. the day of inspection).

BOOK REVIEWS

L'Artillerie aux Manoeuvres de Picardie en 1910. (The Artillery in the Picardy Maneuvers of 1910.) By General Percin of the French Army. Paris: Berger Levrault, 5 Rue des Beaux-Arts. XIX + 252 pp. 6" x 9". 21 plates. 1 map. 1911. Price, $1.50.

This book treats of the employment of the field artillery during the French Grand Maneuvers of 1910 when the 2nd and 3rd Army Corps were the opposing troops. Each corps was provided with its full complement of artillery, viz., 30 batteries organized into ten groups, or battalions as we call them. In each corps, three groups were assigned to each of the two divisions as divisional artillery, while the other four formed the corps artillery. Each battery had four guns and six caissons, its peace strength. Because of his position as inspector general of field artillery target practice, General Percin speaks as an authority on field artillery matters. During the maneuvers, he was the chief umpire which givès him an intimate and first hand knowledge of what took place.

The book is a study in the employment of field artillery pure and simple. The author takes up the operations of each day, giving only so much of the orders, etc., affecting the infantry, as is necessary to a proper understanding of the work of the field artillery. In treating of the operations an excellent plan is followed, in that the criticisms appear in a parallel column on the same page as the action as is being discussed. The movements of the field artillery are very fully treated. The work gives in detail the orders received by the superior field artillery commanders; the instructions given by them in pursuance of their orders; and finally, the action of the groups and batteries in carrying out their instructions, positions taken up, targets fired upon, and the tasks assigned to the individual batteries whether to fire upon opposing artillery or to directly support the infantry attack, etc. Each detachment of field artillery is thus treated separately, the author's comments and criticisms appearing in a parallel column, so that by means of the excellent map and sketches accompanying the volume, it is very easy to follow out what the artillery did as well as what the author thinks they should have done. At the end of the book, he gives a resume of the lessons to be learned from the maneuvers by the field artillery. He dwells most strongly on the need of proper organization of the chain of command and communication with the attacking infantry, and on the need that the field artillery should thoroughly understand its mission before beginning its execution and the necessity of not departing from that legitimate mission except under great emergency or upon orders from the supreme authority under whose command the field artillery at the time may be operating.

The comments and criticisms by the author are very much to the point and are made in a spirit of toleration and impartiality. It is a book well worth reading by every military student, as it throws light upon so many points in connection with the employment of modern field artillery. As our

field artillery tactics are influenced to a greater or lesser degree by the ideas of the French, this book is particularly valuable to those officers of our own army who are seeking information upon the subject of the proper co-operation of all arms on the field of battle. Like most French military writings, the language used is very simple and an extended knowledge of French is not required.

The Principles of Scientific Management. By Frederick Winslow Taylor. New York: Harper & Brothers. 6" x 9". 144 pp. Cloth. 1911. Price, $1.50 net.

It is doubtful whether any "system" enunciated in modern times has so attracted the attention of the industrial world as that set forth, as a result of a lifetime of study, by Mr. Frederick W. Taylor, former president of the American Society of Mechanical Engineers, in his book "The Principles of Scientific Management." Our country has, in recent years, become awakened to the fact that our national resources are in danger of being dissipated; and our people have been warned of the necessity for conservation. In his introduction, the author states that a larger waste is in the lack of proper, or scientific, direction, or co-ordination, of *human* effort; because these efforts are, or seem to be, less tangible than the saving of materials such as water, forests, or minerals.

The underlying motive in presenting this book to the public is to point out:

First: The great loss which the country is suffering through inefficiency in our daily acts.

Second: That the remedy for this inefficiency lies in scientific management.

Third: That this scientific management is based upon clearly defined laws, which are applicable to all human activities.

As a preliminary, the author first presents to the reader a discussion of what are thought to be the fundamentals, or self-evident truths, concerning these principles of management, and upon which they are based. He believes that underworking, or what is commonly called "soldiering," is the greatest evil with which the working people of both England and the United States are now afflicted. As a maxim for industrial progress, the two leading objects of any system of management should be the maximum prosperity of the employer coupled with the maximum prosperity of the employee. The majority of people today, however, believe that the fundamental interests of the employer and the employee are necessarily antagonistic; and that while no one can deny that for the individual the greatest prosperity can exist only when that individual has reached the highest state of efficiency—*i.e.* turning out his largest daily output—the attitude of employers towards the workingman has been that of trying to get the largest amount of work out of him for the smallest possible wages; and the attitude of the employee has been to begrudge the employer a large or even a fair profit, believing that the fruits of his labor belong solely to him. The foundation of scientific management, in the mind of the author, is the firm conviction that prosperity for the employer cannot exist without a similar prosperity for the employee, and vice versa; and that it is possible to give, at the same time, what the workman most wants—high wages—and the employer what he wants—low

labor cost—for his manufactures. Although these fundamentals may seem perfectly clear, and that a better management may develop this higher efficiency, and consequent prosperity, the facts as they exist to-day are these: The American workman is deliberately underworking, to prevent abuse by his fellow workmen, and to protect in his mind, his own interests. There are three causes for these conditions. Briefly summarized they are as follows: first, the fallacy that a material increase in the output of each man or each machine in the trade would result in throwing a number of men out of work; second, the defective methods of management which make it necessary for each workman to "soldier," or work slowly; and, third, the rule-of-thumb methods, now almost universal in each trade, in practising which so many workmen waste their efforts. Perhaps the whole proposition is put, from the workman's view point, in his question: "Why should I work hard when that lazy fellow next to me gets the same pay as I do and does only half as much work?"

The greater portion of the book is devoted by the author to answering the three questions uppermost in the minds of men who become interested in what is termed "scientific management":

First: Wherein do the principles of scientific management differ materially from ordinary management?

Second: Why are better results obtained under scientific management than under other types or systems?

Third: Is it not more important to get the right man at the head of the company, and leave the choice of systems to him?

In order to illustrate and prove the superiority of a system which is the result of a scientific study of the workman's "job," the author first sets forth what he believes to be the finest type of ordinary management at present in existence in most industrial work. This is called the "initiative and incentive" system, or piece work, as distinguished from the "Taylor" or task, system. Under the old, or former, system the management "put it up" to the workman, in the belief that the employee would produce the greatest output if given the greatest pay. Under this type of management success depends upon the initiative of the individual workman, but it is rare that this is ever obtained. Under the Taylor system the initiative is obtained with uniformity, and the management assumes the responsibility of getting together all the best knowledge obtainable which is possessed by all workmen, and by them classified and giving it to the workman to use. The duties of the management are grouped under four heads: (a) to develop the science of each element of the man's work; (b) a selection and training of each workman for his particular task, according to his fitness; (c) a cooperation with the men and an explanation of the system; (d) an equal division of the responsibility between the employer and the employee.

The most prominent single element in modern scientific management is the "task" idea. The work of every workman is planned out in advance, and when he succeeds in doing his task he receives from 30 to 100 per cent. more than his ordinary wages. A number of illustrations are cited by the author to show the practical operation of this plan, which show the increased efficiency resulting from the selection and training of men under proper direction. These illustrations point out that the results obtained depended upon the substitution of a science for the individual judgment of the workman; the proper selection of the workman; and the intimate cooperation with

the workman. It is no single element, but rather a combination of elements, which constitute this system of management. Briefly, they are science—not rule-of-thumb; harmony—not discord; cooperation—not individuality; maximum output—in place of restricted output, and the development of each man toward his greatest efficiency and prosperity.

The author claims that scientific management will mean for the employer and the workman who adopt it the elimination of nearly all causes of dispute and disagreement, and a far greater prosperity and happiness for both.

Taschenbuch der Kriegsflotten. 1912. (Naval Handbook.) By Kapitanleutnant B. Weyer, a. D. Munich, Germany: J. F. Lehmanns Verlag. 5"x6¾". 576 pp. Numerous cuts, sketches, silhouettes and plans of ships. Cloth. Price, M5.

This is the thirteenth edition of this handbook, the annual appearance of which is looked forward to by all interested in naval information. This edition is noteworthy for an increased amount of material and an improved arrangement. Data as to size, speed, armament, armor and personnel is so well arranged as to be readily obtained for any unit of any navy. Photographs and silhouettes of ships are excellent and, the latter especially, assist materially in identifying any ship. Highly interesting is the review of the armament plans of the latest ships, showing the complete revolution which has recently taken place in that respect.

The first part of the chapter on Naval Policy is devoted to the change in artillery, the latest turret construction, the development of torpedo weapons, etc.; the latter part to the endeavors of individual states to improve their navies. The chapter on Naval Interests is contributed by Prof. Harms and Dr. Kurt Marcard, and contains a vast amount of information presented in a most concise manner. The chapter on England is of importance from the German point of view. It shows what they consider the terrible danger the German people are exposed to, until they have a navy which can successfully resist the planned oppression of Germany by England. It is also pointed out that although England has but a comparatively small army, it costs 12.10 marks per capita for maintaining it, while Germany pays but 12.30 for hers. On the other hand, England pays 20.04 marks per capita for the maintenance of its fleet, while Germany expends but 6.85 marks on hers. It is said that if Germany paid as much for her navy as England does, she could have a fleet that would be as superior to England's as her army is at present superior to England's army.

This edition of Weyer's Handbook will, like its predecessors, be very useful to those who may have occasion to use such a work. It is particularly adapted to quickly obtaining information on naval questions.

How to Play the Naval War Game. With a complete set of the latest rules, full instructions and some examples of "wars" that have actually been played. Interleaved for additional notes, rules, etc. By Fred T. Jane. London, England: Sampson, Low, Martson & Company, Ltd., 100 Southwark Street. 7¼" x 10¼". 91 pp. il. Cloth. 1912. Price, 7/6.

Mr. Jane is well known to readers of the JOURNAL, through his Fighting Ships. In an introduction of a half dozen pages, he tells what the "War

Game" is and something of its objects. A set of rules follow, comprising instructions for the beginner, the players, the umpires, etc.; rules governing the play, signalling, battle procedure, including mines and torpedoes, and night operations; aerial warfare, scouting and bomb dropping; commerce attack and defense. There is a short space devoted to the application of the play to naval attack of forts. This has evidently not been developed to any great extent, which is to be regretted.

The last chapter gives examples of actual "wars" which have been played, giving detailed results, with umpire's report.

The rules throughout seem to be well suited to their purpose and we wish sincerely that they were more fully applicable to coast defense work. The book is interleaved, so that new rules, or memoranda, may readily be made available for future use.

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TO

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F— 6	**Revue de Cavalerie.** *5 Rue des Beaux-Arts, Paris.*	*Monthly* *Per year 33 fr*
F—6a	**Revue de L' Aviation.** *8, Rue de la Grange Bateliere, Paris, France.*	*Monthly* *Per year 8 fr*
F— 8	**Revue du Genie Militaire.** *5 Rue des Beaux-Arts, Paris.*	*Monthly* *Per year 27 fr*
F— 9	**Revue d'Infanterie.** *10 Rue Danton, Paris.*	*Monthly* *Per year 25 fr*
F—9c	**Revue Generale de L'Aeronautique,** *Libraire Aeronautique, 40 Rue de Seine, Paris, France.*	*Monthly* *1 fr. 50 per copy*
F—10	**Revue Maritime.** *30 Rue et Passage Dauphine, Paris.*	*Monthly* *Per year 46 fr*
F—11	**Revue Militaire des Armees Etrangeres.** *R. Chapelot et Cie., 30 Rue et Passage Dauphine, Paris.*	*Monthly* *Per year 15fr*
F—11a	**Technique Aeronautique, La** *32 Rue Madame, Paris.*	*Monthly* *Per year 25 fr*
F—12	**Le Yacht—Journal de la Marine.** *55 Rue de Chateaudun, Paris.*	*Weekly* *Per year 22 fr*

GERMANY.

G— 1	**Artilleristische Monatshefte.** *Mohrenstr. 19, Berlin, W. 8.*	*Monthly* *Per year 24 M*

G— 2 **Der Ingenieur.** *Semi-monthly*
Cordel & Renne, Berlin W 15. *Per year 14 M*
47 Fritschestr. 47, Charlottenburg 4.

G— 3 **Eisen-Zeitung.** *Weekly*
Verlag von Otto Elsner, Berlin S. 42. *Per year 12 M*

G— 4 **Kriegstechnische Zeitschrift.** *Ten numbers a year*
Koch Strasse, 68-71, Berlin, S. W. *Per year 10 M*

G— 5 **Marine Rundschau.** *Monthly*
Koch Strasse, 68-71, Berlin, S. W. *Per year 8 M*

G— 6 **Militaer Wochenblatt.** *Semi-weekly*
Beiheft. *Per year 20 M*
Koch Strasse, 68, Berlin, S. W. 12.

G— 7 **Schiffbau.** *Semi-monthly*
Zimmerstr., 8, Berlin, S. W., 68. *Per year 20 M*

G— 8 **Stahl und Eisen.** *Weekly*
Jacobistrasse 5, Düsseldorf. *Per year 24 M*

G— 9 **Ueberall.** *Monthly*
Verlag: Boll und Pickardt, *Per year 12 M*
Georgenstrasse 23, Berlin, N. W.

G—10 **Zeitschrift fuer das Gesamte Schiess- und Sprengstoffwesen.**
J. F. Lehmann's Verlag, Munich. *Fortnightly*
Per year 26 M

ITALY.

I— 0 **Bibliofilo Militar.** *Monthly*
Via Urbana Num. 4, Rome. *Per year 25 l.*

I— 0c **Rendiconti degli Studi ed Esperienze nel Laboratorio di Costruzioni Aeronautiche del Battaglione Spucialist.** *Bi-monthly*
Rome, Italy. *Per year, 13.50L*

I— 1 **L'Ingegneria Ferroviaria.** *Fortnightly*
Via del Leoncino n. 32, Rome. *Per year 20 l.*

I— 1a **Lista Navale Italiana.** *Quarterly*
Rome, Italy. *Per year 15 l.*

I— 2 **Rivista di Artiglieria e Genio.** *Monthly*
Tipografia Enrico Voghera, *Per year 20 l.*
Via Astalli 15, Rome.

I— 3 **Rivista Marittima.** *Monthly*
Economo del Ministero della Marina, *Per year 25 l.*
Rome.

I— 4 **Bollettino Della Societa Aeronautica Italiana.** *Monthly*
Via della Muratte, 70, Rome. *Per year, 18 l.*

PORTUGAL.

P— 1 **Annaes do Club Militar Naval.** *Monthly*
43 Rua do Carmo, Lisbon, Portugal. *Per year $3.85*

P— 2 **Revista de Artilharia.** *Monthly*
Rua do Carmo, 43, 2°, Lisbon. *Per year 12 fr*

P— 3 **Revista de Engenheria Militar.** *Monthly*
27 Rua Nova da Almada, Lisbon. *Per year 16 fr*

P— 4 **Revista Militar.** *Monthly*
Largo da Annunciada, 9, Lisbon. *Per year 2 2400 reis*

RUSSIA.

R— 3	**Imperial Nicholai War Academy Recorder, The.** *St. Petersburg, Russia.*	*Monthly* *Per year 6 rubles*

SCANDINAVIA AND DENMARK.

Sc— 1	**Artilleri-Tidsskrift.** *Artillerigarden, Stockholm, Sweden.*	*Bi-monthly* *Per year, U. S., $1.75*
Sc— 2	**Militaert Tidsskrift.** *Copenhagen, Denmark.*	*Semi-monthly* *Per year, U. S., $2.50*
Sc— 3	**Norsk Artilleri-Tidsskrift.** *Christiania, Norway.*	*Bi-monthly* *Per year, $1.50*
Sc— 4	**Norsk Militaert Tidsskrift.** *Christiania, Norway.*	*Monthly* *Per year, U. S., $2.50*

SPAIN.

Sp— 1	**Memorial de Artilleria.** *Museo de Artilleria, Madrid.*	*Monthly* *Per year, $3.50*
Sp— 2	**Revista Cientifico-Militar.** *Paseo de San Juan, 201, Barcelona.*	*Semi-monthly* *Per year 40 fr*
Sp— 3	**Revista General de Marina.** *Ministerio de Marina, Madrid.*	*Monthly* *Per year $4.45*

SWITZERLAND & BELGIUM.

S— 1	**Allgemeine Schweizerische Militaer-Zeitung.** *Basel, Switzerland.*	*Weekly* *Per year 8 fr*
S— 2	**Revue Militaire Suisse.** *23 Escaliers-du-Marche, Lausanne, Switzerland.*	*Monthly* *Per year 12 fr 50*
S— 3	**Schweizerische Monatschrift fuer Offiziere Aller Waffen.** *Frauenfeld, Switzerland.*	*Monthly* *Per year 5 fr*
S— 4	**Schweizerische Zeitschrift fuer Artillerie und Genie.** *Frauenfeld, Switzerland.*	*Monthly* *Per year 7 fr*
S— 5	**La Belgique Militaire.** *Rue Albert de Latour 50, Schaerbeck, Brussels.*	*Weekly* *Per year 12 fr 50*
S— 6	**Revue de l'Armee Belge.** *24 Rue des Guillemins, Liege, Belgium.*	*Bi-monthly* *Per year 13 fr*

UNITED STATES.

U.S.—0	**Aeronautics.** *1777 Broadway, New York City.*	*Monthly* *Per year $3.00*
U.S.—0aL	**American Historical Review.** *The Macmillan Company, 41 N. Queen Street, Lancaster, Pa., or 66 Fifth Avenue, New York City.*	*Quarterly* *Per yer $4.00*
U.S.—0dL	**American Journal of International Law, The.** *Baker, Voorhis & Co., 45 John St., N.Y.*	*Quarterly* *Per year $5.00*
U.S.— 1	**American Journal of Mathematics.** *Johns Hopkins University, Baltimore, Md.*	*Quarterly* *Per year $5.00*

U.S.— 2	**Arms and The Man.** *1502 H Street, N.W., Washington, D. C.*	*Weekly* *Per year $3.00*
U.S.— 3	**Army and Navy Journal.** *20 Vesey Street, New York.*	*Weekly* *Per year $6.00*
U.S.— 4	**Army and Navy Register.** *Washington, D.C.*	*Weekly* *Per year $3.00*
U.S.—4a	**Bulletin of the American Geographical Society.** *Broadway & 156th Street, New York City.*	*Monthly* *Per year $5.00*
U.S.— 5	**Bulletin of the American Institute of Mining Engineers.** *29 West 39th Street, New York.*	*Bi-Monthy*
U.S.— 6	**Bulletin of the American Mathematical Society.** *501 West 116th Street, New York.*	*Ten numbers per year* *Per year $5.00*
U.S.— 6a	**Bulletin of the Bureau of Standards.** *Department of Commerce and Labor, Washington, D.C.*	
U.S.—6aL	**Bulletin of the International Bureau of the American Republics.** *Washington, D. C.*	*Monthly* *Per year $2.00*
U.S.— 7	**Bulletin of the University of Illinois.** *Urbana, Illinois.*	
U S — 7a	**Bulletin of the University of Wisconsin.** *Madison, Wisconsin.*	*Bi-monthly* *25c per copy*
U.S.—7b	**Bulletins, Bureau of Mines.** *Department of the Interior, Washington, D. C.*	*Occasional* *Free*
U.S.—7cL	**Canal Record.** *Ancon, Canal Zone, Isthmus of Panama.*	*Weekly* *Per copy, 5c*
U.S.— 8	**Cassier's Magazine.** *3 West 29th Street, New York.*	*Monthly* *Per year $3.00*
U.S.—8b	**Compressed Air.** *Compressed Air Magazine Co. Easton, Pa.*	*Monthly* *Per year $1.50*
U.S.—8c	**Confederate Veteran.** *Nashville, Tenn.*	*Monthly* *Per year $1.00*
U.S.— 8a	**Craftsman, The.** *29 W. 34th Street, N. Y.*	*Monthly* *Per year $3.00*
U.S.— 9	**Electric Journal, The.** *422-4 Sixth Ave., Pittsburg, Pa.*	*Monthly* *Per year $1.50*
U.S.—10	**Electrical Review and Western Electrician.** *Heisen Building, 608 South Dearborn Street, Chicago.*	*Weekly* *Per year $3.00*
U.S.—11	**Electrical World.** *239 West 39th Street, New York.*	*Weekly* *Per year $3.00*
U.S.—13	**Engineering Magazine, The.** *140-142 Nassau Street, New York.*	*Monthly* *Per year $3.00*
U.S.—15	**Engineering News.** *220 Broadway, New York.*	*Weekly* *Per year $5.00*
U.S.—16	**Engineering Record.** *239 West 39th Street, New York.*	*Weekly* *Per year $3.00*
U.S.—16d	**Field Artillery Journal, The.** *U. S. Field Artillery Association, 1744 G Street, N. W., Washington, D.C.*	*Quarterly* *Per year, $4.00*
U.S.—16a	**General Electric Review.** *General Electric Company, Schenectady, New York.*	*Monthly.* *Per year $2.00*

U.S.—16b Infantry Journal. *U. S. Infantry Association, Colorado Building, Washington, D. C.*	*Bi-Monthly*	*Per year, $3.00*
U.S:—19L Journal American History. *3 West 43rd Street, New York.*	*Quarterly*	*Per year $3.00*
U.S.—20 Journal American Society of Naval Engineers. *Navy Department, Washington, D.C.*	*Quarterly*	*Per year $5.00*
U.S.—21 Journal of the Association of Engineering Societies. *31 Milk Street, Boston, Mass.*	*Monthly*	*Per year $3.00*
U.S.—22 Journal of the Franklin Institute. *15 South Seventh Street, Philadelphia, Pa.*	*Monthly*	*Per year $5.00*
U.S.—22c Journal of Industrial and Engineering Chemistry. *The American Chemical Society, Easton, Pa.*	*Monthly*	*Per year $6.00*
U.S.—23 Journal of the Military Service Institution. *Governors Island, New York.*	*Bi-monthly*	*Per year $3.00*
U.S.—23a Journal of the U. S. Artillery. *Fort Monroe, Virginia.*	*Bi-monthly*	*Per year $2.50*
U.S.—24 Journal of the U.S. Cavalry Association. *Fort Leavenworth, Kansas.*	*Bi-monthly*	*Per year $2.50*
U.S.—26 Journal of the Western Society of Engineers. *1734 Monadnock Block, Chicago, Illinois.*	*Bi-monthly*	*Per year $3.00*
U.S.—26a Kansas University Science Bulletin. *Lawrence, Kansas.*		
U.S.—27 Machinery. *49-55 Lafayette Street, New York.*	*Monthly*	*Per year $2.50*
U.S.—28 Marine Review. *Cleveland, Ohio.*	*Monthly*	*Per year $1.00*
U. S.—28a Metal Industry, The. *99 John Street, New York.*	*Monthly*	*Per year $1.00*
U.S.—28d Military Digest. *75 Escolta, Manila, P. I.*	*Monthly*	*Per year $1.00*
U.S.—29 Military Surgeon, The. *Union Trust Building, Washington, D. C*	*Monthly*	*Per year $3.50*
U.S.—30 Mines and Minerals. *Scranton, Penn.*	*Monthly*	*Per year $2.00*
U.S.—30d National Defense. *136-140 East Gay St., Columbus, Ohio.*	*Monthly*	*Per year, 50c*
U.S.—30L National Geographic Magazine, The. *Hubbard Memorial Hall, Washington, D. C.*	*Monthly*	*Per year, $2.50*
U.S.—30a National Guard Magazine, The. *Columbus Savings and Trust Building, Columbus, Ohio.*	*Monthly*	*Per year $1.00*
U.S.—31 Navy, The. *Southern Bldg., 15th and H Sts., N.W., Washington, D.C.*	*Monthly*	*Per year $1.50*
U.S.—31d Official Gazette of the United States Patent Office, The. *Supt. of Documents, Gov. Printing Office, Washington, D. C.*	*Weekly*	*Per year $5.00*

U.S.—31a Pennsylvania Magazine of History and Biography. *Quarterly*
Philadelphia, Pa. *Per year $3.00*

U.S.—32 Physical Review. *10 numbers per year*
66 Fifth Avenue, New York. *Per year $5.00*

U.S.—32a Polytechnic, The. *10 numbers per year*
Troy, N. Y. *Per year $1.00*

U.S.—33 Popular Mechanics. *Monthly*
225 Washington Street, Chicago, Ill. *Per year $1.50*

U.S.—34L Proceedings American Institute of Electrical Engineers.
33 West 39th Street, *Monthly*
New York. *Per year $5.00*

U.S.—35 Proceedings of the American Philosophical Society.
104 South Fifth Street, Philadelphia, Pa.

U.S.—36 Proceedings of the American Society of Civil Engineers.
220 West 57th Street, New York. *Monthly*

U.S.—37 Proceedings American Society of Mechanical Engineers.
33 West 39th Street, New York. *Monthly*

U.S.—38 Proceedings of the Engineers' Club of Philadelphia.
1317 Spruce Street, *Quarterly*
Philadelphia, Pa. *Per Vol. $2.00*

U.S.—39 Proceedings of Engineers Society of Western Pennsylvania.
803 Fulton Bldg., *Monthly*
Pittsburg, Pa. *Per year $5.00*

U.S.—40 Proceedings of the U. S. Naval Institute. *Quarterly*
Annapolis, Md. *Per year $3.00*

U.S.—40a Professional Memoirs. *Quarterly*
Washington Barracks, D. C. *Per year $3.00*

U.S.—40b Reactions. *Quarterly*
Goldschmidt Thermit Company, *Free*
90 West Street, New York City.

U.S.—41 Review of Reviews. *Monthly*
13 Astor Place, New York. *Per year $3.00*

U.S.—41b Science. *Weekly*
41 North Queen Street, Lancaster, Pa. *Per year, $5.00*

U.S.—41c Science Conspectus.
Massachusetts Institute of Technology, Boston, Mass.

U.S.—42 Scientific American, The. *Weekly*
361 Broadway, New York. *Per year $3.00*

U.S.—43L Scientific American Supplement. *Weekly*
361 Broadway, New York. *Per year $5.00*

U.S.—43d Scientific Digest, The. *Monthly*
Kansas City Life Building, *Per year $1.00*
Kansas City, Mo.

U.S.—44 Seventh Regiment Gazette, The. *Monthly*
30 West 33rd Street, New York. *Per year $1.50*

U.S.—44b Southern Electrician. *Monthly*
Cotton Publishing Co., Atlanta, Ga. *Per year, 50c*

U.S.—44a Stevens Institute Indicator. *Quarterly*
Hoboken, N. J. *Per year $1.50*

U.S.—44d Technical World Magazine. *Monthly*
1 Madison Avenue, New York, N. Y. *Per year, $1.50*

U.S.—45a Telephone Engineer. *Monthly*
Monadnock Building, Chicago, Ill. *$2.00 per year*
U.S.—46 Transactions of the American Society of Civil Engineers.
220 West 57thStreet, New York.
U.S.—47 Transactions of the Society of Naval Architects and Marine Engineers.
29 West 39th Street, New York.
U.S.—47d University Bulletin. *Monthly*
Louisiana State University, *except Nov. & Dec.*
Baton Rouge, La.
U.S.—47L Virginia Magazine of History and Biography, The.
Virginia Historical Scoiety, *Quarterly*
Richmond, Va. *Per year, $5.00*

MISCELLANEOUS.

M— 0 Boleti Mensel d o Estado aior do Exercito, *Monthly*
Rio de Janeiro, Brazil.
M— 1 Boletin del Centro Naval. *Monthly*
Florida 659, Buenos Aires, Argentine. *Per year $m/n 11.90*
M— 1b Boletin de Ingenieros. *Monthly*
War Dept., Mexico City, Mexico.
M—1a Boletin de Minas. *Monthly*
Lima, Peru.
M— 2 Boletin del Ministerio de Guerra y Marina. *Fortnightly*
Apartado No. 91, Lima, Peru.
M—2c Poletin Militar (Venezuela). *Monthly*
Ministerio de Guerra y Marina,
Caracas, Venezuela.
M—2b Memorial del Estado Mayor del Ejercito de Chile.
Falleres del Estado Mayor-Jeneral. *Bimonthly*
Santiago de Chile.
M—2d O Tiro.
Rio de Janeiro, Brazil.
M—2a Proceedings and Year Book of the Association for Military Science.
34 Maria Street, The Hague, Holland.
M— 3 Revista del Ejercito y Marina. *Monthly*
Departamento de Estado Mayor,
City of Mexico.
M— 4 Revista de Marina. *Monthly*
Casilla del Correo 976, Valparaiso, Chili. *Per year $10.00*
M— 5 Revista Maritima Brazileira. *Monthly*
Rua D. Manoel n. 3, *Per year $6.00*
Rio de Janeiro, Brazil.
M— 6 Revista Militar. *Monthly*
Paseo Colon, Buenos Aires, Argentine. *Per year $9m/n*
M— 7 Revista Militar. *Monthly*
Colegio Militar Avenida 12 de Diciembre, *Per year $3.00*
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M— 8 Revista Militar. *Monthly*
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City of Mexico.

M— 4 Revista de Marina. *Monthly*
Casilla del Correo 976, Valparaiso, Chili. *Per year $10.00*

M— 5 Revista Maritima Brazileira. *Monthly*
Rua D. Manoel n. 3, *Per year $6.00*
Rio de Janeiro, Brazil.

M— 6 Revista Militar.	*Monthly*
Paseo Colon, Buenos Aires, Argentine.	*Per year $9m/n*
M— 7 Revista Militar.	*Monthly*
Colegio Militar Avenida 12 de Diciembre, La Paz, Bolivia.	*Per year $3.00*
M— 8 Revista Militar.	*Monthly*
Rio de Janeiro, Brazil	

Synopsis of Index

As far as possible the entries of the Index are grouped according to the following synopsis:—

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        sights, etc.,
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        interior,
        penetration,
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        artillery, field,
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        steam,
        general,
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fortifications.

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international
military,
municipal.

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recent.

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technical troops,
transport and supply,
medical,
naval.

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artillery, field,
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